The University of Alberta
Printing Department
Edmonton, Alberta

THE UNIVERSITY OF ALBERTA

RELEASE FORM

NAME OF AUTHOR DANIEL M. KIMINYO

TITLE OF THESIS A CROSS-CULTURAL STUDY OF THE DEVELOPMENT OF CONSERVATION OF MASS, WEIGHT AND VOLUME IN KENYAN CHILDREN

DEGREE FOR WHICH THESIS WAS PRESENTED PH.D.

YEAR THIS DEGREE GRANTED SPRING, 1973

THE UNIVERSITY OF ALBERTA

A CROSS-CULTURAL STUDY OF THE DEVELOPMENT OF CONSERVATION OF MASS, WEIGHT, AND VOLUME IN KENYAN CHILDREN

by

© DANIEL MUTUNGI KIMINYO

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES AND RESEARCH

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF EDUCATIONAL PSYCHOLOGY

EDMONTON, ALBERTA

SPRING, 1973

THE UNIVERSITY OF ALBERTA

FACULTY OF GRADUATE STUDIES AND RESEARCH

The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research, for acceptance, a thesis entitled "A Cross-Cultural Study of the Development of Conservation of Mass, Weight, and Volume in Kenyan Children," submitted by Daniel Mutungi Kiminyo in partial fulfilment of the requirements for the degree of Doctor of Philosophy.

ABSTRACT

The study investigated the effects of schooling, urbanization, and sex on the discovery of conservation of Mass, Weight, and Volume in Kamba children in Kenya.

One hundred and twenty subjects were tested of whom sixty were chosen from an urban town and sixty from a rural community sixty miles apart. Both town and rural groups were matched in age, sex and number of years (from 0 to 6) spent in school. Subjects ranged from 7 to 12 years of age. All subjects were tested individually by the author and an assistant in a quiet room using the traditional Piagetian tasks for the conservation of mass, weight, and volume.

A detailed analysis of the data indicated no significant differences between: (a) urban and rural, (b) schooling and non-schooling, (c) male and female subjects in total scores on conservation tasks. Conversely, significant differences were shown to exist between age groups, and between types of conservation tasks. The differences between age groups were similar to those reported for same age groups in European conservation studies. Similarly, the trend of horizontal decalage in the present study agrees with that reported in Genevan conservation studies.

The use of verbal explanations as sufficient criterion for measuring conservation has been questioned, especially in cross-cultural studies. It has been suggested that non-verbal criteria should be designed for assessing conservation. An alternative to verbal explanation as criterion for conservation has been advanced, namely the use of the prediction and judgement tasks, because they do not discriminate against subjects who have inadequate language development.

In conclusion, results indicated that Kamba children discovered conservation sequentially and in accordance with Piaget's theory of cognitive development.

ACKNOWLEDGEMENTS

The writer wishes to thank the Machakos County Educational Officer, Mr. Gideon Wambua, the Principals, Teachers and Pupils in St. Mary's and Kalawa County schools for their co-operation during the collection of data for this study. Thanks are also extended to Dr. W. H. O. Schmidt for excellent supervision and assistance throughout all stages of the study. The writer is also indebted to Dr. R. MacArthur, and Dr. M. Gulutsan for their helpful suggestions, encouragement and discussions from the beginning to the end of my studies in the U. of A.

Special thanks are extended to the Canadian International Development Agency (CIDA) for sponsoring my study in Canada and for their kind sponsorship for the writer to travel to Kenya for the purpose of data collection.

The writer is very grateful to the Kenya Government for granting him a three year leave to study in Canada.

Thanks to the personnel in educational research section of the Department of Educational Psychology for prompt assistance in data analysis, and to fellow students Mr. M. Lawson and M. Richmond for their helpful suggestions and discussions during the preparation of the study.

Kind thanks to Dr. P. R. Dasen, of University of Geneva, for reading my thesis and making excellent suggestions and for his acceptance to be the external examiner.

Finally, and with love, the writer wishes to thank his wife, Alberta, for her advice, patience and hard work during our stay in Canada, and to our son, Kitonga for the five months he was in Kenya without his father.

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CHAPTER I

INTRODUCTION TO THE PROBLEM

Cross-cultural studies in cognitive development are essential in the analysis of factors which are crucial in influencing cognitive development.

Piaget's theory of cognitive development is of special interest to cross-cultural developmental psychologists because of the important role he has attributed to the unfolding of universal biological functions. The testing of the validity of such universal maturational or developmental sequences can only be done through studying cognitive development of children from different cross-cultural backgrounds.

One of the major concepts of Piaget's theory of cognitive development (and one that has been studied most) is the concept of conservation (the invariance of equality, for instance of substance, weight or volume in the face of transformation or deformation) which Piaget considers to be "a necessary condition for all rational activities." (Piaget, 1952).

Studies of various types of conservation have shown conflicting results in connection with the effect of schooling on the acquisition of conservation concepts. One of

the most detailed cross-cultural conservation studies was done by Greenfield (in Bruner et al 1966) in which schooling was found to be a crucial factor influencing the acquisition of conservation of continuous quantities among the Wolof children in Senegal's Urban and Rural populations. Recently, Ciborowski and Cole (1971); Okonji (1971); and Dempsey (1971), have supported Greenfield's main finding that schooling has an important role to play in children's cognitive development especially the conservation concepts.

On the other hand, contrary evidence has been accumulating from studies done by Goodnow and Bethon (1966), and by a great number of cross-cultural studies quoted by Furby (1971).

Similarly, conflicting results have been found concerning the role played by environmental factors on the achievement of conservation concepts. Greenfield, Madiano and Maccoby (Bruner et al 1966) have reported differences in conservation scores between rural and urban children within the same cultural background. Other studies (to be discussed later in chapters II and III of this paper) have found no such differences in conservation scores while others have asserted that rural children conserve earlier than urban children.

The purpose of the present study is to investigate the problems formulated above and to clarify some of the

ambiguities that have been shown to exist in some cross-cultural studies reviewed later in this paper.

Generally, the present study addresses itself to the following problems:

1. What is the role of schooling in the attainment of conservation of mass, weight and volume?
2. What roles do rural and urban environmental factors play in conservation of mass, weight and volume?
3. Does the age-sequential development of conservation which has been shown to exist in western children exist in Kenyan children?
4. Do Kenyan children conserve the three quantities in the same order as the western children?

This study is a replication of Elkind's study "Children's Discovery of the Conservation of Mass, Weight, and Volume: Piaget Replication Study II (Sigel et al. 1968, p. 11)."

CHAPTER II

A REVIEW OF LITERATURE IN DIFFERENT THEORETICAL APPROACHES RELEVANT TO COGNITIVE DEVELOPMENT

The study of cognitive development in children has occupied the lifetime of many researchers (Koffka 1928; Bruner 1957, 1964, 1966; Vygotsky 1962; Galperin 1968, and Piaget, 1941) just to mention a few representative researchers.

The Harvard center of cognitive growth under the direction of Jerome Bruner consistently maintained that cognitive development is achieved through three stages: the Enactive Stage, the Ikonic Stage, and the Symbolic Representation Stage.

The S-R theory (Ripple, 1964) advanced a single-unit model of stimulus-response association. It seems difficult to see how cognitive growth is augmented by the association of stimulus with response. However, the S-R theory becomes more meaningful when the role of language is included. The model now takes a different structure, that of S-r-s-R. This is what is known as the mediational model in which responses are associated not only with specific physical stimuli, but also with the meanings and contexts belonging to these stimuli. Cognitive growth then, must be attained

through association of stimuli with their meanings or mediational responses.

Ausubel (in Ripple, et al. 1964) gives a different view of looking at cognitive growth based on the premise that existing cognitive structures, i.e. an individual's organization, stability and clarity of knowledge in a particular subject matter field at any given time, is the principle factor influencing mental development. Mink (in Ripple et al. 1964) criticizes this theoretical model because it presupposes an existence of organization and stability of knowledge before the child can advance to a higher cognitive growth level.

Most of the cognitive development theories talk of the child's ability to represent or to reconstruct his experiences into meaningful structures. Charlesworth (1964) working with the concept of conservation of substance, has shown that the surprise response indicates cognitive development level and acts as the motivation for curiosity which keeps the child interested in a task longer.

Vygotsky (1962) in his three-phased cognitive growth theoretical model believes that the process of cognitive development is creative and begins with a new problem which the existing structures can not solve. Like the Harvard Center of Cognitive Development, the language "word meaning" is the principal factor in cognitive growth as far as Vygotsky is concerned.

Learning is the means of mental growth in children. Mental "make-up" is set from outside and all its structures must be learned (Galperin 1966, 1968; Kalmykova 1966; Kostyuk 1966; Mechinskaya 1966 et al). This is the main thesis of the Soviet Union child development psychologists. Generally, the cognitive development, according to Soviet psychologists, occupies two stages. In the first stage, the child acts on the external objects by means of manipulation, and, in the second stage, the child acts or carries an action in his mind - the latter is an idea of the action while the former is material action. The main role in mental growth is played by the word which names the necessary concepts.

PIAGET'S EARLY EXPERIMENTS IN CONSERVATION OF QUANTITY

Jean Piaget has dealt with the many phases of mental growth systematically one by one (Language and Thought, 1926; Judgement and Reasoning, 1928; Child's Concept of the World, 1929; Child's Concept of Physical Causality 1930 (a); The Moral Judgement of the Child 1932; The Psychology of Intelligence 1950 (a); The Child Conception of Number 1952 (b); The Origin of Intelligence in Children 1952 (c); the Construction of Reality in the Child 1954 (a); The Development of Quantities in the Child 1941); and The Early Growth of Logic in the Child 1964).

Piaget's work on cognitive growth falls generally into four major stages. The Period of Sensory - motor Intelligence from 0 - 2 years; the period of preoperational representations 2 - 7 years; the concrete operations - 7 - 11 years, and the Period of Formal Operations 11 - 15 years.

The concrete operational period has a special importance in that it is in this period the child comes to realize that transformation* of substance does not alter the amount of substance, its weight or its volume unless some parts are eigher removed or added to the first quantity.

In his first experiments (Piaget and Inhelder 1941, in Flavell, 1963) Piaget reported that conservation of mass was acquired between the ages of 8 - 9 years; weight between 10 - 11 years and volume, at 12 years.

The second experiment studied 100 children of 4 - 12 years of age. Firstly, the subjects were given two identical glasses with equal amount of water and used a balance to establish equivalence of weight. Three pieces of sugar were put in one of the glasses and the height of water in the glass was marked. The children were asked questions to find out what would be conserved, sweet taste substance, weight or volume.

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*Other important concrete operations (e.g. seriation and classification) appear in this period also.

The results from this experiment showed that there were three developmental stages for the concept of conservation.

(a) In the first developmental stage, children appeared to think that sugar is lost when it dissolves in water.

(b) In the second stage, children have various transitional phases. They believe that sugar is not really lost but it still exists in small or tiny particles which are invisible. But they do not yet have the conservation of weight.

(c) The final stage comes in when the children see the invariance of weight, then, volume just in the same order as Piaget had found before in the conservation of mass, weight and volume of clay balls.

Piaget did another experiment using popcorn in which children were asked whether or not the amount of matter and weight have changed after heating a piece of popcorn until it popped up (Piaget and Inhelder 1941; Flavell 1963).

Again, Piaget draws two major conclusions from the results of this and the other experiments.

I 1. The evolution of quantity concepts, begins with a confused and undifferentiated state in the mind of the young children and slowly emerges from this undifferentiated totality to separate and stable concepts. There is no concept of matter or weight or volume in the beginning which is separate from each of the others.

2. A little later, amount of matter differentiates from the conglomerative concept to become a rational affair for which conservation is achieved - in which subquantities always sum up to the same total quantity. However, weight and volume are still undifferentiated.

3. Still later, these two separate from each other and each becomes a genuine quantity concept at its own time.

II A genuine understanding of volume concept and its relation to weight requires the development of a schema of substance density and related concepts concerning density and related concepts concerning compression and decompression of matter. Piaget has shown that as soon as children start showing conservation of volume, they also show evidence of understanding the following concepts - that the substances are made up of numerous tiny parts with empty spaces in between. Substances can vary as to how tightly the tiny

parts are compressed, i.e. some volume is occupied by air and some by the substance and that objects which are small and heavier than large ones are tightly packed but the large ones are loosely packed with a lot of empty spaces in between. The children finally achieve the concept of volume conservation only through this schema about the nature of matter.

REVIEW OF REPRESENTATIVE STUDIES ON THE CONCEPT OF CONSERVATION

Piaget's contention is that the concept of conservation of matter, weight and volume is related to age-levels. The concept of matter conservation appears around the age of 8 - 9 years, the conservation of weight at 9 - 11 years and the volume conservation at the age of 12 or above.

The second contention is that the development of the conservation concept has three developmental stages:

(a) Non-conservation stage

(b) Transitional stage and

(c) Conservation stage.

The following studies are concerned with replication and training techniques to induce conservation in children usually younger than the years Piaget gives for emergence of the conservation concepts. Investigated also is the

order of emergence of the concept in different quantities and the developmental stages mentioned above.

REPLICATION STUDIES

Flavell (1963) has reviewed a great number of studies on the conservation of quantity and he reports that Piaget's original studies have been generally confirmed. The conservation of matter appears first, then the conservation of weight and finally the conservation of volume. The same studies report that the child first has no conservation concept, then he indicates conservation and a few minutes later he denies it. The final stage comes in when the child starts regarding the question demanding conservation as an obvious one.

Another series of studies (Elkind 1961 II, 1961 IV) dealing with quantity conservation has shown that children 7 - 8 years old achieved the conservation of mass, 9 - 10 years had weight conservation and that there was no volume conservation before the age of 11 years. The children in these studies showed the three Piagetian developmental stages too. In the first stage, they had only general impressions of quantity but were capable of judging crude weight, mass, and volume differences. In the second stage they differentiated mass from both weight and volume and in the third and final stage, they differentiated weight from volume.

Ogilvie and Lovell (1960) studied children 7 - 10:8 years in England Junior Schools and confirmed Piaget's developmental stages in the development of the concept of conservation.

Commenting on age-sequential conservation, the authors feel that there are no clear cut borders between age stages but what seems to be true are zones rather than border lines. Children in this study seemed to confuse meanings of longer, shorter, fatter, bigger, thicker and smaller which most replicative studies use. The same authors (1961) studied the concept of volume conservation in 1st, 2nd, 3rd, and 4th year junior school children and found that this concept comes much later in children.

Another study (Uzgiris 1964) investigated the possibility of a child to conserve substance, weight and volume of one kind of material and fail to conserve the same in a different kind of material. The subjects were children taken from 1st through 6th grades in Illinois schools.

Uzgiris concludes that the results of the study support Piaget's theory of sequential intellectual development and particularly, the sequential attainment of conservation of substance, weight and volume in this order by each individual child. Murray (1970) and Phillips (1967) undertook similar studies. (Using second grade children as

subjects and concrete objects, photographs of the objects, line drawings of the objects and verbal descriptions as the four types of materials). Subjects were tested for conservation of weight. The number of conservers was compared with the number of non-conservers in the four types of materials. Highly insignificant differences in the proportions of conservers and non-conservers were found between the four groups of second graders. Murray however, found significant differences between the older and younger subjects and also between higher and lower socioeconomic groups in their conservation scores.

It is helpful to review Piaget's basic properties of cognitive development before a review of intervention studies is made since these studies are based on these basic properties. Piaget (1952; also Flavell 1963; Maier 1965; Hunt McV. 1961) has suggested a cognitive development based on two major factors:

(a) Structure and

(b) Function.

The structures change with age and they are organizational properties of cognition which are created through activity of the subject. By function, Piaget means those broad characteristics of cognitive activity which hold true for all ages and which define the essence of intelligent behavior.

Piaget believes that structures and functions of one's cognition are basically biological in the sense that inherited biological structures condition what the subject may perceive (species-specific inheritance). Structures are not inherited as such but a mode of intellectual functionings is what is inherited. The process of cognitive functioning remains invariant throughout development stages regardless of various changes in cognitive structures. Two of these invariant cognitive functionings are organization and adaption.

Piaget (Flavell 1963 p. 46) defined cognitive organization as totalities, systems of relationships among elements. Every act of intelligence presumes some kind of cognitive structure, some sort of organization within which it proceeds. As to the nature of this organization, its specific characteristics, like those of biological organizations, differ greatly from stage to stage in development. On the other hand cognitive functioning is characterized by the invariant process of adaption through its two processes of assimilation and accommodation which go on simultaneously and are only abstractions of the same activity.

Piaget explains it in the following way:

> ". . . However, "pure" assimilation and "pure" accommodation nowhere obtain in cognitive life; intellectual acts always presuppose each in the same measure.
>
> . . . From the beginning assimilation and accommodation are indissociable from each other. Accommodation of mental structures to reality implies the existence of assimilatory schemata apart from which any structure would be impossible. Inversely, the formation of schemata through assimilation entails the utilization of external realities to which the former must accommodate, however crudely.
>
> Assimilation can never be pure because incorporating new elements into its earlier schemata the intelligence constantly modifies the latter in order to adjust them to new elements. Conversely things are never known by themselves, since this work of accommodation is only possible as a function of the inverse process of assimilation" (in Flavell 1963, p. 49)

Cognitive growth according to Piaget progresses through the continuous and extended accommodatory acts on new and different features of the surrounding environment. Once the new and different features are assimilated, they tend to change the structure in some degree and through this change make it possible for further accommodatory extensions. Assimilation of new structures depends on past familiar systems. There must already be a system of meanings or an existing organization which can be modified to admit assimilation.

Piaget sums it up this way:

> Assimilation is by its very nature conservative in the sense that its primary function is to make the unfamiliar familiar, to reduce the new to the old. A new assimilatory structure must always be some variate of the last one acquired, and it is this which insures both the gradualness and continuity of intellectual development. (In Flavell 1963, p. 50).

The schema has been advanced by Piaget to be the internal organization or system of meanings to which new features are assimilated or through which accommodation is effected. One of the most relevant schemas to this paper is what Piaget calls the schema of intuitive qualitative correspondence. This schema refers to a strategy by which the child tries to assess whether or not two sets of elements are numerically equivalent.

During the age of 7 - 11 years (concrete operations) there appear what Piaget calls operational schemas. Among these schemas are the infralogical operational schemas involving quantity and measurements. The child affirms the operation of reversibility - performs an action (A), then returns to the starting point by an inverse action (A_1), then repeats the direct action (A) again (Flavell 1963, p. 136). The child has tightly knit ensembles of reversable operations which enable him to organize and stabilize the surrounding world of objects and events to a degree quite impossible to the younger child in pre-operational stage. It is also in this middle child period where the child acquires the grouping schemas - schemas which enable him to add and subtract classes of objects and multiply classes of objects.

Piaget believes that cognitive growth is contributed by four factors - nervous maturation, encounters with

experience, social transmission, and equilibration or auto-regulation. The first three do play a role but they are insufficient. "Individual's cognitive development is mainly due to the process of equilibration where the individual is the active motor and coordinator of his own development," (Ripple 1964, p. 10).

Piaget sees little sense in intensive specific training on one-to-one tasks. If a child is taught that the amount of clay stays the same when a ball is made into a pancake, the learning is not likely to have a general effect on his level of understanding. He explains the situation by saying that there are two kinds of experience which are involved in learning. Firstly, there is physical experience consisting of action upon the object and drawing some knowledge about the object by abstraction from the object. Secondly, there is logical-mathematical experience where the knowledge is not drawn from the object, but it is drawn by the actions effected upon objects. This is the experience necessary before there can be operations. Training techniques succeed in the physical experience learning but not in the logical-mathematical experience. Piaget argues that the concept of conservation of weight and volume is not due only to experience, but also involves a logical framework which is characterized by the understanding of the concept of reversibility.

The true test for training contribution to cognitive growth lies in the answers to these questions: How long does the acquired knowledge last? Can this knowledge be transferred to a new problem? If the answer to both questions is yes, then training would have effect on cognitive growth.

The following studies are representative of a great number of studies dealing with at least one of Piaget's four factors interacting in the acquisition of conservation skills. Most of them are concerned with the use of different theories of learning in their attempt to teach conservation skills in young children.

A REVIEW OF INTERVENTION STUDIES ON CONSERVATION TASKS

Many investigators [Smedslund 1961a, 1961b, 1961c, 1961d; Wallach 1967; (in Sigel 1968); Lunzer *et al*. 1955; Wohlwill 1962; Bruner *et al*. 1966] have been involved in different methods of training for conservation in subjects who, according to Piaget's theory of cognitive development, are too young to have concept of conservation. These researchers start with the hypothesis that the concept of conservation is attained through learning rather than through maturational and environmental interactions.

Smedslund (1961a) discusses the possibility of influence on conservation of substance and weight by learning, reinforcement, and maturation. He has found that learning and maturation contribute to conservation to a limited extent but that internalization of one's experience is the main factor influencing the attainment of conservation. Smedslund asserts that conservation induced through learning can be extinguished and that concept of conservation attained through internal structuring of one's experience can not be extinguished. This study, Smedslund claims, refutes the assertion by learning theorists that conservation is achieved through external reinforcement. In another study (1961d) Smedslund trained children aged 5 1/2 to 6 1/2 years to conserve substance and weight by two methods - addition/ substraction and deformation. Results from this study show that children who were trained through addition/substraction method attained higher scores in conservation tasks than those who followed deformation method. Hence, cognitive growth can be influenced by solution of conflict situation rather than by perceptual cues.

Wohlwill (1962) carried out a similar study to those of Smedslund but making use of several training approaches. The first group was trained through reinforcement practice, second group was trained through addition - substraction method and discussion was carried out with the

third group. The fourth group was control group. Subjects were kindergarten children with average age of 5 years and 10 months. There were no significant differences among training groups with respect to learning of conservation, but it increased as a function of training especially in the addition - substraction method confirming Smedslund's conclusion.

Elkind (1961) investigated the assertion that conservation is a function of materials used. Using sticks, liquids and beads, he tested the conservation of these materials using subjects from 4 to 7 years old. The results showed that the correlation for types of material were highly significant.

Carpenter and Lunzer (1955) investigated the hypothesis that type of reasoning shown by young children is not constant from situation to situation, type of reasoning is affected by the content of a problem and its form; there is a positive relationship between Piaget's tests and mental ages of subjects. Subjects were 5 to 9 year olds. Results showed that type of reasoning stayed constant from situation to situation; some subjects were affected by the form of the problem but past experience and visual perception helped the subject to overcome the conflict. It was also found that mental age correlated highly with total scores of Piagetian tests. A three stage

conservation development was likewise confirmed by this study. These findings have been replicated by Feigenbaun (in Flavell 1963) who has reported that conservation of discontinuous quantities had been highly correlated with age and I.Q. of subjects. Feigenbaum concludes that some training procedures facilitate conservation while others do not.

Shantz and Sigel (1967) of Merrill Palmer Institute have asserted that Piaget has been concerned with the presence-absence of conservation and related processes but has not focused experimentally on the factors which can account for the learning of conservation. To investigate such factors, they conducted a research to determine the relative effectiveness of two particular group training procedures designed to induce conservation and to assess the relationship between conservation and logical operations of classification, seriation, and reversibility. The two procedures were labelling and classification skills, and discrimination-memory training. The study showed that both training procedures unlike Mermelstein's, induced conservation but neither method was significantly more effective than the other. There was a limited relationship between conservation and logical operations. Some investigations have claimed that the concept of weight, mass, and volume conservation can be induced in young children. (Young 1969;

Lefrancois 1968). Using a multivariate training approach, Young managed to induce some significant gain on the pre-test scores of his children and concluded that the concepts could be learned by 3 and 4 year olds. Overbeck and Schwartz (1970) have also shown that some training techniques induce conservation more than others. In their study they used reinforcement, passive observation, active participation as variables. Their conclusion was that reinforcement facilitated acquisition of conservation of weight while active and passive participation was shown to have no effect on the acquisition of conservation of weight. This finding is contrary to the studies by Smedslund (1961) as mentioned earlier in this paper. Stafford and Renner (1970) and Baptiste (1969) believe that conservation can be facilitated by instruction. Children 6 years old who were non-conservers were divided into two groups and taught science following two different types of curriculum - the traditional and the improved science curriculum. Results showed that there was a greater growth in conservation skills among the experimental group than among the control group. A different approach in training techniques was introduced by Murray (1971) in which non-conservers were grouped together with conservers and each group was asked to respond with one group answer to a series of conservation problems. This approach uses social interaction as a means of acquisition of conservation through

conflicting or opposing points of view. Children who were non-conservers made the greatest gains in conservation scores. As it was said earlier, the main problem in training for conservation is how long the acquired concept can last and whether or not it can be transferred to new situations.

Kincaid et al. (1971) trained middle class children of 3 and 4 years old to conserve classification and seriation. Three conservation tasks were given as post-tests to assess transfer after completion of training. There was no correlation between training and transfer.

Conservation Training and Social Economic Status (SES)

Almy, Chittenden, and Miller (1966) reviewed studies on training procedures and their effects on the attainment of conservation and the relevance of the concept to children's progress and achievement in kindergarten, first, and second grades. The results support Piaget's findings and enhance the educational importance of the understanding of conservation. Children's performances in conservation tasks in both longitudinal and cross-sectional studies have been shown to fall into patterns indicating a similar sequence in the attainment of conservation. While this sequence held for children in schools in different neighborhoods, the progress from one level of understanding to the next was considerably slower for the children who came from the lower class background. The consistency of findings insofar as the sequence

was concerned, underscored the importance of maturational factors in the children's abilities to conserve.

Mermelstein (1967, 1968) trained children from kindergarten using four training procedures - cognitive conflict, language activation, multiple classification, and verbal instruction. He reported that the Piagetian concept of conservation of substance was not induced by any of the training techniques and that language interfered with acquisition of the concept of conservation of substance. [Piaget has pointed out this characteristic function of language (Ripple et al. 1964)]. A contrary finding to what (Almy et al. 1966) has been reported above was that socio-economic class level had no influence on achievement of conservation in children 4 - 6 years old. A different training procedure was used by Blum (1967) of the University of Boston. Children 4 - 9 years old were trained to deal with perceptual confusions so that they could utilize this understanding to disregard irrelevant changes, such as spatial rearrangement of quantity. Results showed that middle class 7 and 8 year olds were much better conservers before training than their Head Start peers, but all groups appeared to benefit greatly from the training procedure and were facilitated in learning conservation.

Bozarth (1968) has found significant differences between high and low socioeconomic levels in conservation

task scores and positive relationship between intelligence and conservation scores in fourth grade children. Another study relevant to the ones mentioned above was carried out at the University of Illinois (Wei 1969) in which middle and lower class children were compared in their performances of the Piagetian concept of classification. The results of the study showed that the ability to classify increases with age and that there were significant differences between the performances of middle class children and those of lower class children. A number of recent studies (Baker and Sullivan 1970; Hilliard 1971) confirm the results of the earlier studies that there are differences between middle and lower socioeconomic children's scores on conservation tasks. Baker trained kindergarten children to conserve inequality and concluded that children conserved according to their interest in the material - such as candy, toys and beans. Conservation ability was manifested significantly more often by middle class than by lower class female children. A positive correlation was also found between conservation scores and tasks involving addition-substraction concepts. Although there seem to be differences between middle and lower class children's scores on conservation tasks, Hilliard has found no score differences after training lower class Mexican - American children using Piaget's tasks emphasizing manipulation, classification of number, size,

weight, and reversibility concepts. Neither the experimental nor the control group scored significantly more than the other on conservation post-tests, but both traditional and Piagetian methods of teaching arithmetic induced conservation.

Asked whether or not development of children's thinking could be accelerated by practice, training and exercise in perception and memory, Piaget replied:

> I am not very sure that exercise of perception and memory would be sufficient, I think that we must distinguish within the cognitive function two different aspects which I shall call the figurative aspect and the operative aspect. The figurative aspect deals with static configurations . . . .
>
> In cognitive functioning one has the figurative aspect for example, perception, imitation and mental imagery.
>
> Secondly, there is the operative aspect including operations and the actions which lead from one state to another. In children of high stages and in adults, the figurative aspects are subordinated to the operational aspect. . . . . The pre-operational child does not understand transformations. He does not have the operations necessary to understand them so he puts all emphasis on the static quality of states.
>
> . . . . In exercising perception and memory, I feel that you will reinforce the figurative aspect without touching the operative aspect. Consequently, I am not sure that this will accelerate the development of cognitive structures. What needs to be reinforced is the operational aspect . . . not the analysis of states, but the understanding of transformations." (Ripple 1964, p. 20).

Another area investigators reported in this paper have been concerned with is that of emergence of stages and their related operations. Some researchers have questioned Piaget's age-sequential stages in the sense that young children have shown some understanding of Piagetian concepts

of conservation before the time Piaget locates for them. But Piaget explains this phenomenon when he asserts:

> "In our research we say that a problem is solved by children of a certain age when three-quarters of the children of this age respond correctly. As a result, to say that a question is solved at seven years old means that already one-half of the six - year olds can solve it, and a third of the five - year olds etc. So it's essentially relative to a statistical convention. Secondly, it's relative to the society in which one is working. We did our work in Geneva and ages that I quote are the ages we found there. I know that in certain societies for instance in Martinique, where our experiments have been done by Monique Laurendau and Father Pinard we have found a systematic delay of three or four years. Consequently, the age at which those problems are solved is also relative to the society in question. What is important about these stages is the order of succession. The mean chronological age is variable" (Ripple 1964, p. 31)

SUMMARY

The review of intervention studies in this chapter has shown overwhelmingly that some kind of learning of conservation skills takes place as a result of training procedures. Acquisition of conservation skills through training has been confirmed by Smedslund (1961a); Wohlwill (1962); Braine (1959); Shantz and Sigel (1967); Lefrancois (1968); Young (1969); Baptiste (1969); Stafford and Renner (1970); Swartz (1970); Hilliard (1971); and Murray (1971). Only Smedslund (1967, 1968) failed to confirm training effects on conservation. A few researchers have concerned themselves with Piaget's criteria for true acquisition of conservation concepts as mentioned earlier. Among these are Bruner, *et al*.

(1966); Kohnstamm (1967); Carey and Steffe (1969); Rattan (1970); and Kincaid (1971). These studies have applied Piaget's transferability criterion to assess the effect of training on conservation skills. All but Kincaid's study, reported significant measure of transfer of conservation skills to other conceptual tasks. It should be pointed out that Kincaid worked with kindergarten children and age-level could have had some effect on the children's performance. Several studies have found significant differences in conservation scores between middle and lower socioeconomic levels (Almy et al. 1966; Blum, 1967; Bozarth, 1968; Wei, 1969; Baker and Sullivan, 1970; and Hilliard, 1971).

Furthermore, the conservation concept has generally been confirmed to develop sequentially and in relation to type of quantity and age-level.

A great deal of time has been spent reviewing the intervention studies because schooling, which is a form of intervention is an independent variable in the present study. Secondly, if concrete operations can be speeded up, it is important to know which theoretical framework works the best in speeding up these operations.

CHAPTER III

REVIEW OF CROSS-CULTURAL LITERATURE ON CONSERVATION CONCEPT

Piaget's theoretical model assumes that

(a) Mental growth is governed by a continual activity aimed at balancing the intrusions of the social and physical environment with the organism's need to conserve its structure systems (subject-object equilibrium)

(b) There are some conceptualizations in children that are independent of histori-cultural conditions (Piaget 1967).

The implications of these assumptions have led investigators to carry out studies in different cultures because of their divergent socializing techniques, and secondly, to investigate the possibility of there being some conceptualizations which are not affected by these socializing techniques. Bruner (1966), agreeing with the first assumption has said that "Insofar as man's powers are expressed and amplified through the instruments of culture, the limits to which he can attain excellence of intellect must surely be as wide as are the culture's combined capabilities (p. 326)."

The understanding of the contribution of social and physical environment to child's mental growth was appreciated by Koffka (1928) when he said,

> "The world appears otherwise to us than it does to an African in central Africa. We speak a different language from either, and this difference is a fundamental one, inasmuch as real translation of their words into our own is impossible, because the categories of thought are different, (p. 339)."

Many investigators have carried out cross-cultural studies on mental development [Segal, Campbell, and Herskovits 1966; Lesser, Fifer and Clark 1965; Jahoda 1966; Vernon 1966; all quoted by Goodnow in Hellmuth 1970; McFie 1961; Vernon 1965]. Their results show differences among cultures in availability of different mental functions. Jahoda (1956) working with Ghanaian children has found that tests of abstract behavior were no more culture-free than intelligence tests.

One of the earliest cross-cultural conservation studies was done by Hyde (1959) using Indian, Arabic, Somali and European children. It was found that non-European children conserved weight before substance and sometimes volume before they could conserve weight. Goodnow and Bethon (1966) have reported that Chinese unschooled children scored as high as European and average American children on conservation of surface, weight and volume, but considerably

lower on combinatorial tasks. Greenfield (in Bruner 1966) has reported that Wolof children establish identity between the past and the present to achieve conservation for instance - "This one and that one were/are equal" (p. 255) and thus, they do not utilize the language of identity (same) or the classification of the present situation according to both appearance and reality - to express identity like the western children. Nevertheless, conservation of substance was complete by the age of 11 years. She also found that schooling was a crucial factor in acquisition of conservation of continuous quantities.

Maccoby and Madiano (Bruner 1966) working with American and Mexican children found significant differences between rural and city children on classification tasks which led them to speculate that formulation of equivalence judgements may depend more on cultural traits than individual abilities.

Again, Nezvadovitz and Pomares (1968) at the university of Havana tested two groups of children who had been taught mathematics using two approaches. Results showed that all children conserved volume earlier than substance and weight contradicting Piaget's order. And Roll (1970) has speculated that there are more similarities than differences in across-cultural strata in cognitive development of children. He made this conclusion after comparing American

with Colombian children from lower and middle socioeconomic classes. Vernon (1966) and Kleinfield (1970) have found that Eskimo children possess unusual cognitive strengths in the areas of perceptual analysis and image memory. Their measures were found to equal the norms for the American children. Again, Vernon (1965) has argued that as we move away to a less technological society, there is no overall lag or retardation across tasks but "peaks" and "troughs." Some tasks shift their difficulty level more than others. He found that tasks concerning amount, weight, and volume (among a few others) have shown consistency throughout cultures. Studies have shown that dull, average, unschooled and school children from the same culture have the same patterns of difficulties (Goodnow in Hellmuth 1970). These patterns are shown in figures 1 and 2.

The pattern of performance of the American children can be easily differentiated from the one of Chinese children. It may be argued that it is not school only that influences performances in conservation tasks but more so the culture one happens to live in. The Chinese unschooled children outscored their American peers in several conservation tasks and underscored them in others showing acquisition of special concepts through their cultural experiences. Additional cross-cultural studies in the development of concrete operations have reported contradictory results.

FIGURE I

Patterns of Task Difficulty for English and West Indian Schoolboys (Vernon 1965)

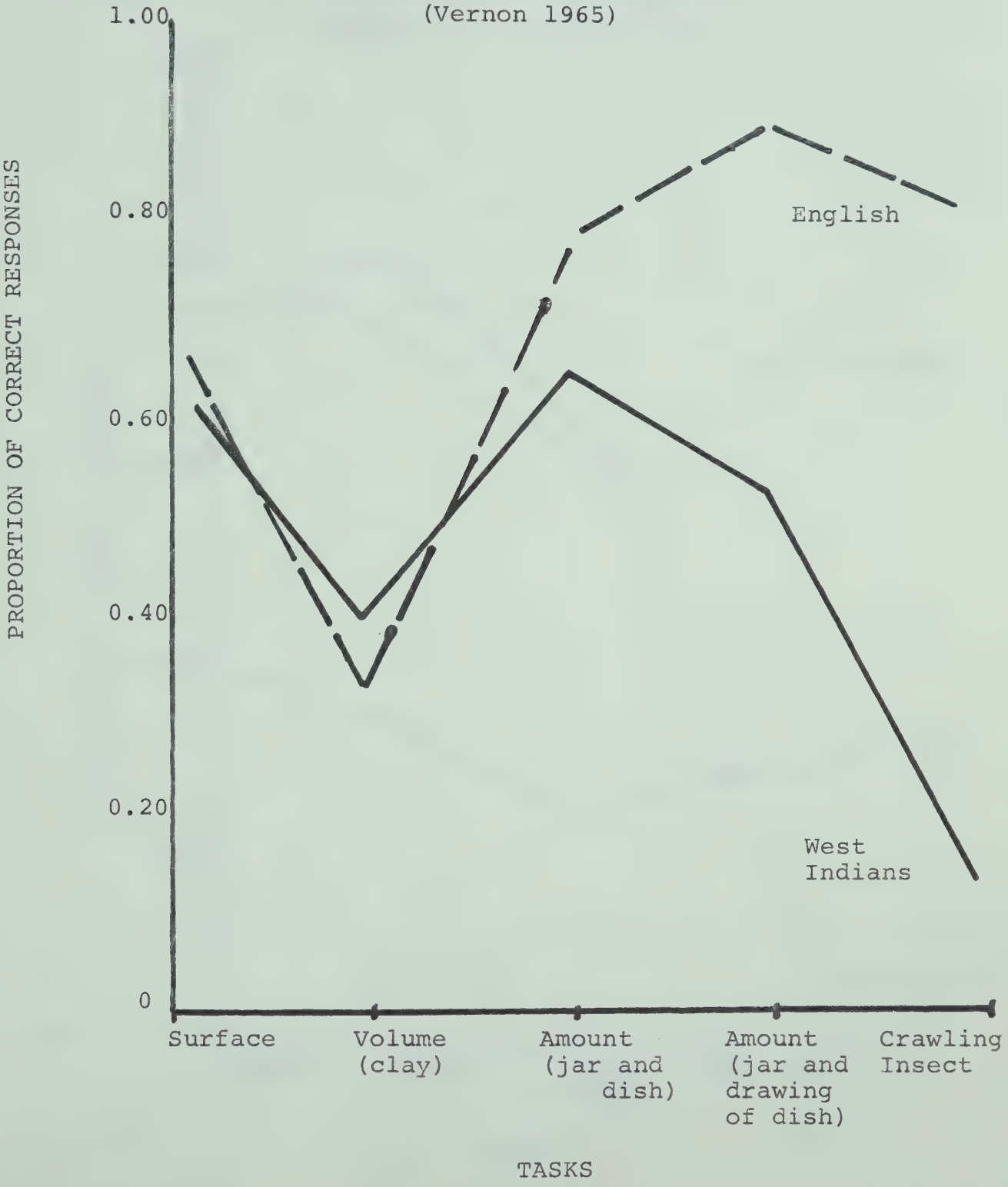
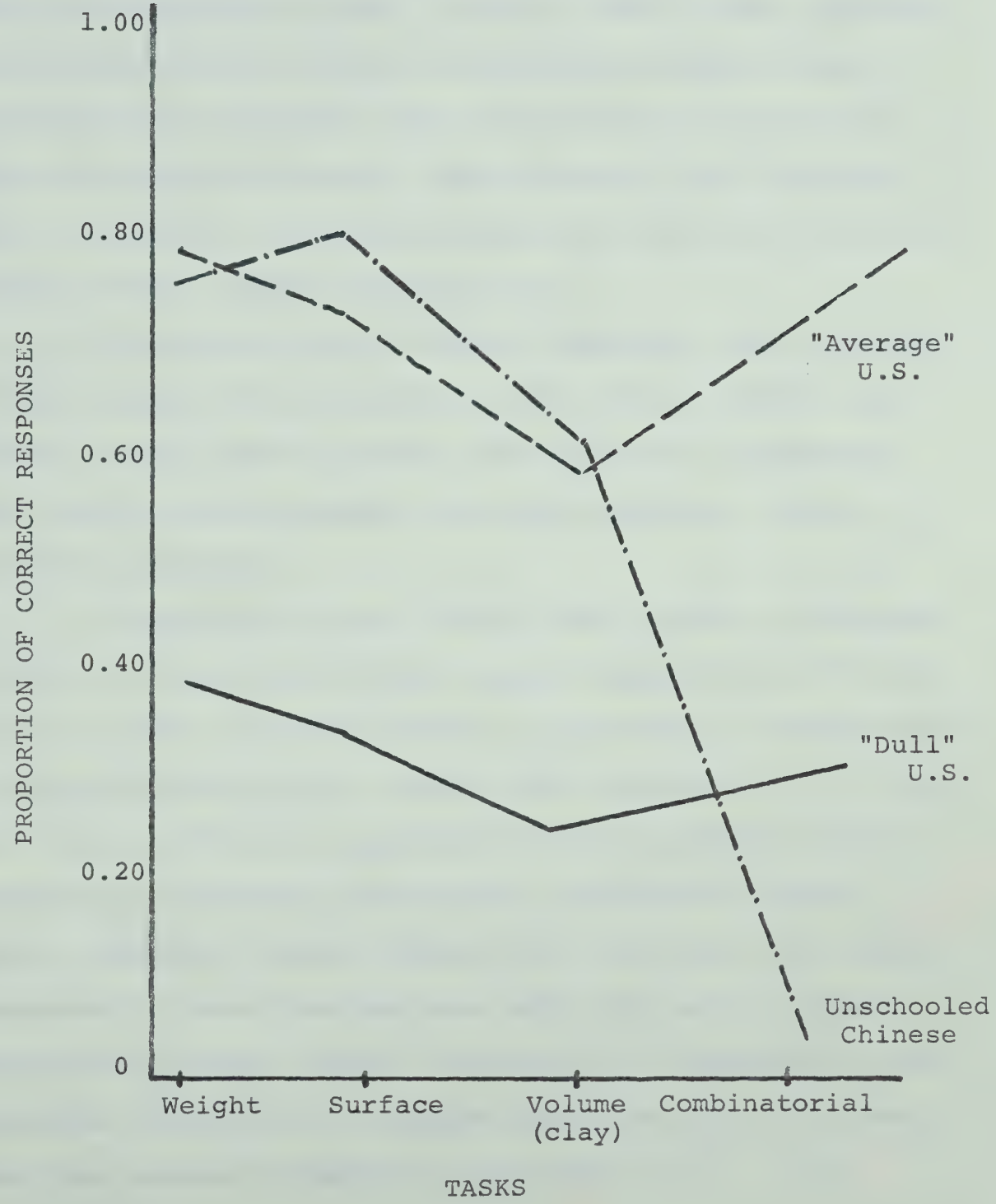


FIGURE 2

Patterns of Difficulty Ss Varying in Nationality, Schooling, and Intelligence (Goodnow and Belton, 1966)



Price-William (1961); Mohseni (1966); (cited by Dasen, 1972) found no differences between Tiv and European children and between Teheran and European children, respectively, in conservation tasks. Similar results were reported by De Lacey (1970a) between Australian Aboriginals and Europeans and by Okonji (1971) between European and non-European in classificatory tasks; Dampsey (1971) between American Indians, Mexican Americans and Europeans; and Lloyd (1971) between Yoruba and Americans.

A number of other studies (Hendrikz, 1966; Za'rour, 1971a; Vernon, 1969. In Dasen, 1972); Bovet (1968); Hyde (1959), 1970; and Almy (1970) have reported a systematic time lag in the development of conservation in various cultural settings.

In addition, Dasen (1972) cited studies by Boonsong (1968) in which Thai children lacked conservation of weight at age 13; Prince (1968c,1969a) in which 80% of conservation of mass and weight were found in New Guineans 16 to 18 years old; Dasen (1970) who reported little conservation among Australian Aboriginal adolescents; and Waddell (1968); Prince (1968a,b); Kelly (1970a,1971) who found also lack of conservation among New Guineans aged from 12 to 15 years. Heron and Simonsson (1969) reported 50% of Zambian children achieved conservation of weight after the age of 11 years and then reached an asymptote of 55-60%.

Some of the studies cited above investigated development of conservation in adults. Ponzo (In Dasen, 1972) found conservation uncretain among Tukano Adults (Amazon); Waddell (1968) and Kelly (1970) found relatively little conservation in illiterate adults in the Highlands of New Guinea. Similarly, Prince (1968a) found many trainees of teachers' college in New Guinea did not have conservation of mass, weight, and volume. De lemos (1969b) reported that only 50% of adult Australian Aboriginals had the conservation of mass whereas Dasen (1970) found no conservation of mass, weight and volume (using the 75% criterion) among the low and medium contact adult Australian Aboriginals.

On the qeustion of horizontal decalage, some studies have confirmed it and others have not. The conservation sequence (mass, weight, and volume) of difficulty has been confirmed by Bat-Haee (1971); Mohseni (1966); Ponzo (In Peluffo, 1967); Boonsong (1968); Prince (1968c, 1969a); (all cited by Dasen, 1972).

Hyde's and Nezcadovitz's studies mentioned earlier reported that the conservation of weight was considerably easier than the conservation of mass. Similar results were reported by De Lemos (1969b) but this mass/weight reversal was not found when Dasen (1970, in Dasen, 1972) replicated De Lemos's study. What Dasen found was that the develcpment of conservation of weight and volume was more or less simultaneous.

SUMMARY

The studies reviewed in this chapter have shown interesting points. Firstly, it was shown that children within a given culture tend to show the same patterns of difficulties. Secondly, some researchers have reported no differences between European and non-European children in their discovery of concrete operations while on the other hand a number of others have reported a time lag in the discovery of the same operations between cultures. Thirdly, additional studies reported conservation only among teenagers and others reported lack of conservation in adults from different cultures.

The following chapter discusses some of the factors that might account for cross-cultural differences in the development of conservation.

CHAPTER IV

RATIONALE AND GENERAL HYPOTHESES

RATIONALE

The literature review in the second chapter has shown general agreement with Piaget's sequential theory of cognitive development among European subjects. The third chapter was devoted to literature review in Non-European cultures. These studies have shown some contradictory results. While the sequential development of mental growth was found to exist among Non-European subjects, the predicted sequence of conservation in different quantities was not conclusive.

There are at least two problems arising from these Non-European studies. These problems may be the causes of the contradictory results obtained from the studies.

1. Sociocultural Factors

Piaget (Ripple 1964) reported that problems are solved relative to the culture in question and that the important fact is the order of appearance of stages. Stages in the development of cognition have been confirmed in Non-European cultures (sometimes with time lag), but what these studies have not investigated conclusively are the types of experiences that best help the development of

conservation of different quantities. It is the contention of this writer that the type of experiences may be found among those activities within a culture that are useful and vital for survival.

Inhelder (Green et al 1971) agreed that children who are present on occasions when adults evaluate quantities of goods they wish to buy or sell will develop conservation of mass and weight much earlier than otherwise. Similarly, children whose mothers distribute food in containers of various shapes and sizes may learn to pay more attention to the initial act of distribution than to the perceptual appearance of the food in the containers. Furthermore, children who accompany adults to their daily activities will most likely develop those concepts which are necessary for the activities much faster than others. These seemingly culture-specific experiences may be the causes of the conflicting results obtained by several researchers.

Goodnow (1962); Goodnow and Bethony (1966); Mermelstein and Shulman (1967); Waddell (1968); Kelly (1970); and Heron (1971) [in Dasen 1972] reported no direct relationship between formal schooling and conservation. Conversely, direct relationship between schooling and conservation was reported by Greenfield (1966); Hendrikz (1968); Prince (1968a); Lloyd (1971); and Pinard et al (1969).

2. Lack of Actual Replication

Each and everyone of the studies reported in chapter three in this paper was a new experiment dealing with some aspects of one or more European studies. It seems a better way of comparing European and Non-European studies would be replication of actual European studies. In addition, the materials used should be very meaningful and familiar to the subjects. Dasen (1972) emphasized the importance of actual replication. He felt that most cross-cultural studies have shown rather heterogeneous results because each project has been based on different tasks. Cross-cultural research should now concentrate in actual replication of other cross-cultural major studies in the field.

GENERAL HYPOTHESES

The present study addresses itself to the two areas of difficulties as formulated above:

1. It is an actual replication of Piaget's experiments on conservation of mass, weight and volume [see Piaget and Inhelder (1941); and Elkind (Sigel and Hooper 1968)].

2. It attempts to link conservation to specific experiences. These are the vital and survival activities, in which the whole culture finds them necessary to perform.

Like other cross-cultural studies reported above, conservation studies in Africa have reported conflicting results.

Urban/Rural

Urban/Rural differences are linked to European contacts. Greenfield, (1966) found that Rural subjects conserved earlier than Urban subjects, while Lloyd (1971), found the contrary to be true and Price-Williams, (1961) found no difference between both groups.

The Kamba people (from which the sample in the present study was taken) are traditionally small scale agriculturalists. They provide ample opportunity for the children to watch and participate in adult activities such as weeding, harvesting, selling and buying of produce, and distribution of property such as food and livestock.

Urban children do not have this opportunity as much as Rural children because there are few gardens in towns and their parents are workers in factories, shops or as domestic servants. Similarly, the introduction of dishes of the same shapes and sizes may influence Urban children to pay more attention to perceptual appearance rather than to the initial distribution process.

While it is more likely for Urban children to develop other concepts such as those of geometrical shapes earlier

than rural children because of their familiarity and presence in their environment, they would probably develop conservation of mass, weight, and volume much later than Rural children. These considerations lead to the following hypothesis.

HYPOTHESIS I

Rural children will give significantly more conserving responses than urban children.

SCHOOL/NON-SCHOOLING

Conservation studies in African cultures have been very few but they have reported schooling as one of the principal factors influencing the development of conservation. [Greenfield, 1966; Hendrikz, 1966; Price-Williams, 1961; Lloyd, 1971].

This is a very interesting finding because it raises at least, two important questions.

(a) What do schools provide for children that is missing in informal learning?

(b) Are there some variables other than schooling which may be responsible for the high scores on conservation but they have been overlooked?

In response to the first question, the writer's experience with western education in African settings is that it teaches language skills and rules for performance

in examinations. Children in school have little time for the freedom needed for autoregulating experiences which according to Piaget are crucial in the development of conservation. Conversely, they are taught ready made rules to deal with their environmental problems rather than learning them through acting on the environmental problems. Kamii and Derman (Green, et al, 1971) reported a disadvantage of this type of schooling. Preoperational children were taught rules for conservation. When tested for conservation, they gave conserving responses but when they were questioned further they reverted to answers typical of their preoperational development stage. Their answers were illogical and indicated illogical transfer of the concepts they had "learned."

In conclusion then, it may be said (among other differences) that school children mainly differ from non-school children in the extent to which they use formal rules.

In reference to question two, three points are in order. Firstly, the quality of conservation among school children may be questionable. Schools in most traditional African cultures have not yet related school life to community life. Children live an entirely different life in schools from their life in the community. Most of the skills and rules learned in schools are never really taken seriously and therefore, never used in real life except for

examination in schools. Children will clean their school uniforms but fail to clean their beddings and clothing worn out of school. They are told to boil water before it is used for drinking purposes, but they may never do so. The argument here is that although school children seemingly give more conserving responses than non-school children (see studies mentioned earlier) they may be using rules and guess work. The school subculture teaches children to give responses regardless of their correctness to every question. This type of teaching encourages guessing on the part of the children.

Secondly, in African cultures (particularly among the Kamba of Kenya) to ask a child the question, why? after he has made a statement means the statement is wrong and therefore it should be corrected. The child then changes his statement to a new one. This variable may be responsible for the low scores among the non-school children in the studies mentioned earlier.

The third point to be made concerns the experimenter's rapport with children. The use of local assistant experimenters is risky because they may tell the experimenter what they think he/she wants to know. On the contrary learning the local language to run the interviewing, the experimenter runs even greater risks. In most cases knowledge of local language is not a compensation for

cultural and racial differences. Children perform their best when they have good rapport with and confidence in the experimenter. This is rarely the case in most cross-cultural studies in Africa.

Among the Kamba people of Kenya, schools deal with language skills and rules as developed in this paper. The curriculum contains isolated facts which must be memorized for examinations but of limited use in the local community. While school children spend days in these kinds of experiences, the non-school children spend theirs in activities related to their real life in the community. This leads to the following hypothesis.

HYPOTHESIS II

Unschooled children will give significantly more conserving responses than school children.

SEX DIFFERENCES

Among the adult activities, cooking, sharing food, collecting firewood, and drawing of water are exclusively women's activities. These are related to conservation of mass, volume and weight. This leads to hypothesis III.

HYPOTHESIS III

Girls will give significantly more conserving responses than boys.

TYPE OF QUANTITY AND AGE

In the original experiments of Piaget and Inhelder (1941) and Elkind (Sigel et al 1968) it was reported that conservation depends on the type of quantity and the level of age. This leads to hypotheses IV, V, and VI.

HYPOTHESIS IV

The number of conserving responses will vary significantly with the type of quantity (mass, weight and volume).

HYPOTHESIS V

The number of conserving responses will vary significantly with age level.

HYPOTHESIS VI

The number of conserving responses will vary significantly with the type of quantity independent of age level and with age-level independent of type of quantity.

Additional hypothesis dealing with family sizes is discussed in Appendix D.

Some of the hypotheses were stated contrary to the most popular hypotheses in conservation tasks because they followed the logic of the rationale developed for the study.

CHAPTER V

EXPERIMENTAL PROCEDURE

Subjects

One hundred and twenty (120) subjects were tested for this study of which sixty were taken from a rural area and sixty from an urban area. Similarly, sixty were in school and sixty had never been to school. Subjects chosen were from seven to twelve years old and those attending school were in grade one through six.

School subjects were randomly chosen from their class registers. Seven year olds were in grade one, eight year olds in second grade and the oldest subjects in sixth grade.

The experimenter (E) chose five subjects from each class register [either two boys and three girls or three boys and two girls depending on the number of each sex chosen in the previous grade] to make a total of thirty school subjects in each of the two schools. Schools had sought and verified the exact ages of all their children before admission, but it was a little more difficult to assess the age of the subjects who were not attending school. But this difficulty was overcome by consulting birth registers in the District Commissioner's (DC) office

and by taking subjects from parents who had recorded the birth dates of their children. In the rural area some children had not been registered with the DC's office. The experimenter relied mostly on exact birth date records supplemented by a third method in which mothers were asked to tell the experimenter when possible, who else among the better educated neighbours gave birth in the same months in which they gave birth to their children in question.

Five subjects were then randomly chosen from a longer list of children of the same age, to make a total of sixty unschooled subjects (30 in urban and 30 in rural).

Population

Urban. The urban population from which the sample was taken was about fourteen thousand. St. Mary's school from which urban school children were taken was in Machakos, the largest town and capital of the Kamba people of Kenya. Most people worked in the town as laborers and a small number as civil servants. Running water and power were supplied to most residential areas surrounding the town. Daily public transportation by buses was available to all rural areas from the town. Most of St. Mary's children came from the working class. The unschooled subjects from the town were mainly from poor or broken homes. The poor parents could not support their children through school and

still feed them from the small salary they earned as laborers or domestic servants at the middle class homes. The poor children who did not go to school spent their time with grandparents if their parents were working. Older children were employed by richer people to attend their livestock and as babysitters.

Rural. Kalawa Primary School from which rural school children were taken was about sixty miles East of Machakos Town. People in the rural areas did not live in villages with houses near each other but each homestead was one to two miles away from the next. The total population of these isolated homes was three thousand. The main differences between urban and rural areas are given below. In the rural area life was characterized by subsistence farming, lack of running water and power, and insufficient public transportation. All rural people worked on their small farms. Children who did not go to school worked with their parents and sometimes served as messengers to the local shops to buy salt, sugar, and sell eggs, chicken, fruits and milk. Parents of school and unschooled children were equally poor or equally rich. Their income was from their farm produce which included dairy products unlike the town people whose main income came from employment. Both St. Mary's and Kalawa Schools shared the same syllabuses and supposedly comparable

teachers' competence.

PROCEDURE

All subjects were divided into three age groups; 7 - 8 year olds formed Group I; 9 - 10 year olds Group II; and 11 - 12 year olds Group III.

Subjects were interviewed individually in a quiet room provided by the headmasters in the two schools, with a table and three chairs.

Each subject was led into the room and asked to sit on a chair opposite the experimenter* (E). The assistant experimenter (AE) sat at the corner of the table and recorded verbatim the subject's responses. Before another subject was asked to come in the room the E and AE compared their records to make sure they matched completely. Each subject was tested for conservation of mass (CM), conservation of weight (CW), and for conservation of volume (CV) in this order. A maximum of forty-five minutes was taken by the slowest subjects to go through the three tasks.

Conservation of Mass

Each subject was given two equal and three unequal balls made from wheatflour. [All subjects were very familiar with local bread of different shapes and sizes made from

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*The experimenter who is the author of this paper is a member of the Kamba tribe from which all subjects were chosen. Thus, he was competent in language and cultural sophistication of the subjects.

wheat flour]. Then S was asked to choose from the five balls any two that were the same. If S did not find any two balls equal, he was asked to make them equal by taking some pieces away from the larger ball and adding them to the smaller one. After he had ascertained the equality of any two balls the E proceeded in the following manner.

1. Suppose I make this ball here into a pancake, will there be the same amount to eat in the pancake as in that ball or not?

2. Now I am making this ball into a pancake (while the S looks on) is there the same amount to eat in the pancake as in the ball or not?

3. Why do you think so?

These questions were translated into E's and S's own language as follows:

1. Twasye nienda kumba mukate wa kyavati kuma muvilani uu na sikonzi kuma muvilani usu waku. Nuu ula wiithiwa na liu mwingi wauya kana uliu niwianene?

2. Sisya yuyu ningumba mukate kuma muvilani uu. Nuu ula wina liu mwingi wauya kana uliu niwianene?

3. Niki?

Conservation of Weight

Ss were asked to weigh two balls on the scale

balance* provided for them. When they were certain the balls weighed the same, the E asked the following questions:

1. Suppose I make this ball into a pancake, will the weight of the pancake be the same as the weight of this ball or not?

2. Now I am making this ball into a pancake, does it now weigh the same as your ball or not?

3. Why do you think so?

Translation:

1. Twayse nienda kumba muvila uu utwike mukate wa kyavati. Yu uito wa mukate uu ukeethiwa o undu umwe na uito wa muvila uu kana tiwo?
2. Sisya yuyu ningumba mukate kuma muvilani uu. Uito wa mukate uu yuyu ni undu umwe na uito wa muvila usu kana tiwo?
3. Niki?

Conservation of Volume

Each S was presented with a glass jar filled with some water and asked these questions:

1. Suppose I put this ball into the water in the jar, will it raise the water to the same point as your ball?

2. Now I am putting my ball into the water, can you mark the water level. I am making your ball into a pancake, if I put the pancake in the water will the

*The weigh balance was an ordinary one with two basin like containers on both sides and center point hung from a beam in the ceiling.

water come up to the same level or not?

3. Why do you think so?

Translation:

1. Twasye nienda kwikia muvila uu kiwuni kii. Naku wienda kwikia usu waku okiwuni kii. Muvila usu waku ukambatye kiwu oundu umwe na muvila uu wakwa kana tiwo?
2. Sisya yuyu nineekia muvila kiwuni, nutonya kwikia alama vala kiwu kyavika. Sisya ingi ningumba muvila uu utwike mukate wa kyavati. Yu ngekia mukate uu kiwuni wukilya kiwu kikavika alamani ino kana tiwo?
3. Niki?

Scoring

For the purpose of this study, only two questions have been considered necessary for the evaluation of conservation.

(a) the prediction question, and,

(b) the judgement question.

The justification question was given and its responses used to prove the point raised earlier in this study. Lloyd, (1971) reported that the justification of conservation was a performance variable rather than inference of formal conservation system. Quoting

Smedslund, (1969) she reported that similar results were found among European children. Dasen (personal communication) found Australian Aborigines, like the Kambas changed their answers when they were asked to justify them. This therefore, was the reason for leaving out the justification question.

For the two other questions scoring was done in the following procedure. A non-conservation response was given 0 and transitional response 1. Two points were given to a conserving response. In this way, a correct prediction response equals 2 points and a correct judgement response 2 points making a total of 4 points for each of the three types of conservation.

ANALYSIS OF DATA

Scores for CM, CW, and CV were analysed separately using a 4-way analysis of variance. Tests were performed using this design for the main effects:

(a) Environment

(b) Schooling

(c) Sex

(d) Age level and their interactions

1. To test for horizontal décalage (the emergence of one type of conservation before another), a single factor experiment with repeated measures (Winer 1962, 105-152) was run.

2. The Scheffe multiple comparison of means was carried out to determine differences between means for all conservation quantities.

3. A Two-factor analysis of variance with repeated measures on factor "A" was performed to obtain joint effect of age and type of quantity.

4. In addition, data was obtained on family size, and a two-factor analysis of variance was run to obtain the effects of age and family size. Scheffe multiple comparison of means was also done.

CHAPTER VI

RESULTS AND DISCUSSION

Actual results showing exact number of subjects in each of the three developmental stages (Non-Conservation, Transitional, and Conservation) for each conservation task are shown in Table 1. For the purpose of detailed data analysis, scores for all subjects were collapsed into the three age groups shown in Table 1. The three conservation tasks were taken as repeated measures to test for hypotheses IV, V and VI. Each conservation task was analysed separately using a 4-way analysis of variance design giving comparisons between urban and rural, school vs unschooled; male vs female and age group I vs II vs III and their interactions. The summary of the results (Tables 2, 3, and 4) shows insignificant differences between urban and rural subjects in CM (MS = 3.36 and 3.26) and CW (MS = 2.58; 2.48) but a slightly significant difference in their performance in CV (MS = 2.33 & 1.73) ($F = 4.64$, $F.95\ (1,96) = 4.00$) in favor of urban subjects. Hypothesis I had predicted that rural subjects would score higher than urban subjects. In the light of these results the hypothesis was rejected in favor of a statement that urban experiences seem to influence the development of conservation as much as rural experiences do.

TABLE 1

Number of Subjects in Non-Conservation (NC), Transitional (T), and Conservation (C) Stages for Mass, Weight, and Volume at Successive Age Groups

Conservation Task	Age Groups											
	7-8 years				9-10 years				11-12 years			
	N	NC	T	C	N	NC	T	C	N	NC	T	C
MASS												
Pred. Q.	40	11	1	28	40	3	0	37	40	0	0	40
Judg. Q.	40	19	1	20	40	5	2	33	40	1	0	39
WEIGHT												
Pred. Q.	40	21	0	19	40	13	0	27	40	3	0	37
Judg. Q.	40	26	2	12	40	16	1	23	40	7	1	32
VOLUME												
Pred. Q.	40	27	1	12	40	19	1	20	40	10	2	28
Judg. Q.	40	30	1	9	40	21	0	19	40	8	1	31

TABLE 2

A SUMMARY SHOWING THE EFFECTS OF ENVIRONMENT (A) EDUCATION (B), AGE(C), AND SEX(D) ON THE ACQUISITION OF CONSERVATION OF MASS

SUMMARY OF RESULTS					
Source	DF	SS	MS	F	P
Subject	119	191.97			
A	1	0.30	0.30	0.2474	0.62004
B	1	0.03	0.03	0.0275	0.86866
A vs B	1	2.70	2.70	2.2268	0.13891
C	2	48.27	24.13	19.9038**	0.00000
A vs C	2	0.80	0.40	0.3299	0.71981
D	1	0.13	0.13	0.1100	0.74091
A vs D	1	0.13	0.13	0.1100	0.74091
B cs C	2	0.27	0.13	0.1100	0.89598
A vs B vs C	2	9.60	4.80	3.9588*	0.02228
B vs D	1	0.13	0.13	0.1100	0.74091
A vs B vs D	1	0.13	0.13	0.1100	0.74091
C vs D	2	2.87	1.43	1.1821	0.31105
A vs C vs D	2	1.67	0.83	0.6873	0.50539
B vs C vs D	2	4.07	2.03	1.6770	0.19237
A vs B vs C vs D	2	4.47	2.23	1.8419	0.16406
Error					
A B C D	96	116.40	1.21		
		F.99(2,96) = 4.98		F.95(2,96) = 3.15	

**Sign. P < 0.01

*Sign. P < 0.05

TABLE 3

A SUMMARY SHOWING THE EFFECTS OF ENVIRONMENT (A) EDUCATION(B), AGE(C), AND SEX(D) ON THE ACQUISITION OF CONSERVATION OF WEIGHT

SUMMARY OF RESULTS					
Source	DF	SS	MS	F	P
Subject	119	321.87			
A	1	0.30	0.30	0.1457	0.70348
B	1	1.63	1.63	0.7935	0.37527
A vs B	1	0.13	0.13	0.0648	0.79964
C	2	70.32	35.16	17.0810**	0.00000
A vs C	2	1.85	0.93	0.4494	0.63935
D	1	2.13	2.13	1.0364	0.31121
A vs D	1	2.70	2.70	1.3117	0.25493
B vs C	2	1.32	0.66	0.3198	0.72703
A vs B vs C	2	4.32	2.16	1.0486	0.35441
B vs D	1	1.63	1.63	0.7935	0.37527
A vs B vs D	1	2.13	2.13	1.0364	0.31121
C vs D	2	6.02	3.01	1.4615	0.23698
A vs C vs D	2	8.15	4.07	1.9798	0.14370
B vs C vs D	2	20.82	10.41	5.0567**	0.00817
A vs B vs C vs D	2	0.82	0.41	0.1984	0.82039
Error					
A B C D	96	197.60	2.06		

F.99(2,96) = 4.79

**Sign. P < 0.01

TABLE 4

A SUMMARY SHOWING THE EFFECTS OF ENVIRONMENT (A) EDUCATION(B), AGE(C), AND SEX(D) ON THE ACQUISITION OF CONSERVATION OF VOLUME

SUMMARY OF RESULTS					
Source	DF	SS	MS	F	P
Subject	119	389.87			
A	1	10.80	10.80	4.6452*	0.03364
B	1	0.30	0.30	0.1290	0.72023
A vs B	1	20.83	20.83	8.9606**	0.00351
C	2	74.32	37.16	15.9821**	0.00000
A vs C	2	13.65	6.82	2.9355	0.05788
D	1	0.0	0.0	0.0	1.00000
A vs D	1	0.13	0.13	0.0573	0.81125
B vs C	2	9.15	4.58	1.9677	0.14536
A vs B vs C	2	3.02	1.51	0.6487	0.52498
B vs D	1	7.50	7.50	3.2258	0.07564
A vs B vs D	1	0.30	0.30	0.1290	0.72023
C vs D	2	8.15	4.07	1.7257	0.17881
A vs C vs D	2	11.22	5.61	2.4122	0.09503
B vs C vs D	2	0.65	0.33	0.1398	0.86972
A vs B vs C vs D	2	6.65	3.32	1.4301	0.24433
Error A B C D	96	223.20	2.33		
		F.95(1,96) = 4.00		F.95(2,96) = 3.15	

**Sign. P < 0.01

*Sign. P < 0.05

Another look at the summaries (Tables 2, 3, and 4) indicate highly insignificant differences between school and unschooled subjects in all three conservation tasks. This finding contradicts other studies reported earlier (Greenfield, 1966; Hendrikz, 1966; Price-William, 1961) and Lloyd, 1971) whose results showed schooling as a principal factor in the development of conservation of quantities. It seems evident that schools do not do a better job in providing experiences necessary for conservation development than informal education does. Although the hypothesis that "unschooled subjects will give significantly more conserving responses than school subjects" must be rejected, the results of this study show that the causal explanations must come from elsewhere.

The third hypothesis was that female subjects would give significantly more conserving responses than male subjects. Females scored higher than males in CM (MF = 3.40; Mm - 3.13) and exactly the same in CV (Mf = 2.03; Mm = 2.03) but slightly lower in CW (Mf = 2.40; Mm = 2.66) but the summary shows insignificant differences between them. This finding of no difference in performances on conservation tasks between sexes confirms results obtained in European and non-European cultures.

A different design was used to test for hypothesis IV which dealt with horizontal décalage (or time lag)

between the appearances of CM, CW and CV. A single factor analysis of variance with repeated measures was performed treating the conservation tasks as the repeated measures. Examination of mean scores for mass, weight and volume showed the mean score for mass (3.31) was much greater than the mean score for weight (2.53) and volume (2.03) but the mean score for weight is still larger than the mean score for volume. The summary for this test is shown in Table 5 which shows highly significant differences between types of quantity ($F = 31.37$) confirming Piaget's original findings (1940) and Elkind's replication study II (Sigel et al. 1968) which reported that conservation tasks were significantly related to type of quantity.

A conclusion arrived at from the same studies by Piaget and Elkind was the concern of the fifth hypothesis of the present study. Conservation development was found to be related to age levels of subjects. In the present study two tests were performed to obtain main age effects. The 4-way analysis of variance (Tables 2, 3 & 4) gives an F ratio of 19.9 for conservation of mass, an F ratio of 17.08 for conservation of weight, and an F ratio of 15.98 for conservation of volume, which are all highly significant [$F.99\ (2,96) = 4.98$].

The probability matrix for Scheffe multiple comparison of means was used to determine any differences

TABLE 5

A SUMMARY SHOWING COMPARISONS OF TOTAL SCORES FOR EACH OF THE THREE QUANTITIES (MASS, WEIGHT, AND VOLUME)

SUMMARY OF RESULTS

Source of Variance	SS	DF	MS	F
Between People	522.79	119	4.39	
Within People	481.33	240	2.01	
Treatments	100.42	2	50.21	31.37*
Residual	380.91	238	1.60	
Total	1004.12	359		

*Sign P < 0.01

between means. Table 6 shows comparisons between means for conservation of mass ($M_1 = 2.45; M_2 = 3.55; M_3 = 3.95$).

Comparisons between groups I and II, and between I and III give significant differences but a comparison between groups II and III give a non-significant difference. This is what would be expected to happen because group I has not yet achieved conservation but groups II and III have already achieved it.

Table 7 shows similar comparison for the conservation of weight. The means for the three groups are significantly different ($M_1 = 1.60$, $M_2 = 2.54$, $M_3 = 3.48$). Examination of the raw data (Appendix C) showed twenty-two and one half (22 1/2%) per cent conservers in group I, fifty per cent (50%) conservers in group II and seventy-seven and one half (77 1/2%) per cent conservers in group III. As expected, the first two groups had not achieved the seventy-five per cent (75%) conservation criterion although fifty per cent (50%) of group II were already conserving weight as compared to twenty-two and one half per cent (22 1/2%) of the youngest group.

Comparison of means (1.10; 1.98; 2.03) for conservation of volume (Table 8) shows significant differences only between groups I and III; and between groups II and III confirming the expected results that only group III had significantly approached the conservation criterion by having

TABLE 6

PROBABILITY MATRIX FOR SCHEFFE MULTIPLE COMPARISON OF MEANS FOR CONSERVATION OF MASS

Age Group	1	2	3
1	1.00	0.00**	0.00**
2	0.00	1.00	0.27*
3	0.00	0.27	1.00

**Significant P < .05

*Non-significant

TABLE 7

PROBABILITY MATRIX FOR SCHEFFE MULTIPLE COMPARISON OF MEANS FOR CONSERVATION OF WEIGHT

Age Group	1	2	3
1	1.00	0.021**	0.00**
2	0.021	1.00	0.017**
3	0.00	0.017	1.00

**Significant P < 0.05

TABLE 8

PROBABILITY MATRIX FOR SCHEFFE MULTIPLE COMPARISON OF MEANS FOR CONSERVATION OF VOLUME

Age Group	1	2	3
1	1.00	0.06*	0.00**
2	0.06	1.00	0.01**
3	0.00	0.01	1.00

**Significant P < 0.05

*Non-significant.

sixty-seven and one half per cent (67 1/2%) conservers as compared to forty per cent (40%) in group II and only twelve and one half per cent (12 1/2%) in group I.

The last hypothesis to be tested stated that "conservation responses will vary significantly according to the type of quantity and age level". Put in other words it was predicted that all groups will score highest in mass and lowest in volume tasks but the same scores will show significant differences between age groups. A two factor analysis of variance with repeated measures on factor "A" was done and results summarised in Table 9.

The age main effect was highly significant [F = 32.8; F.99 (2,117) = 4.79] as well as the quantity main effect [F = 31.26; F.99 (2,234) = 4.61]

DISCUSSION OF RESULTS

General Discussion

Elkind's, "Piaget's Replication Study II" (Sigel et al 1968) which was replicated in this study gives average number of conservation responses for Mass as 2.08, the average number given for Weight as 1.75, and the average number for Volume as 0.25 giving the same order of difficulty as the order that Piaget had observed. The present study obtained the following average numbers of conservation responses for the same quantities: mass 3.31, weight 2.53,

TABLE 9

A SUMMARY SHOWING EFFECTS OF AGE AND TYPES OF CONSERVATION TASKS

Source of Variance	SS	DF	MS	F	P
Between Subjects	522.79	119			
(A) Age main effect	187.82	2	93.9	32.80*	.0000007
Subject within groups	334.97	117	2.86		
Within Subjects	481.33	240			
(B) Quantity main effect	100.42	2	50.21	31.26*	0.0000
AxB Interaction	5.075	4	1.269	.79	0.53
BxSubject within groups	375.83	234	1.606		

*Highly significant F.99 (2,117) = 4.79

F.99 (2,234) = 4.61

and for volume 2.03. The fact that the average scores for Kenyan children are higher than those tested by Elkind in the United States should not surprise anyone since Elkind included 5 and 6 year olds who for obvious reasons scored much less than the other children. It seems for Kenyan children that the decalage between conservation of weight and volume is not as distinctive as it is with the American children (see figure 3). This difference could be attributed to the environmental factors - the subsistence agricultural life the Kenyans lead with much practical and concrete use of materials as opposed to much more abstract and analytical thinking emphasized by Western education. Elkind confirmed Piaget's observation that other things being equal, conservation responses increased with age. An F for age level was 14.38 and was significant beyond the .01 level. In the present study an F for age level was observed to be 32.8 and significant beyond the .001 level, confirming Elkind's results that the magnitude of the age level means (AI = 1.71, AII = 2.68, and AIII = 3.48)* increased significantly with age.

Elkind's study showed that variations in differences between age groups for each type of quantity appeared as the effect of the type of quantity and age level.

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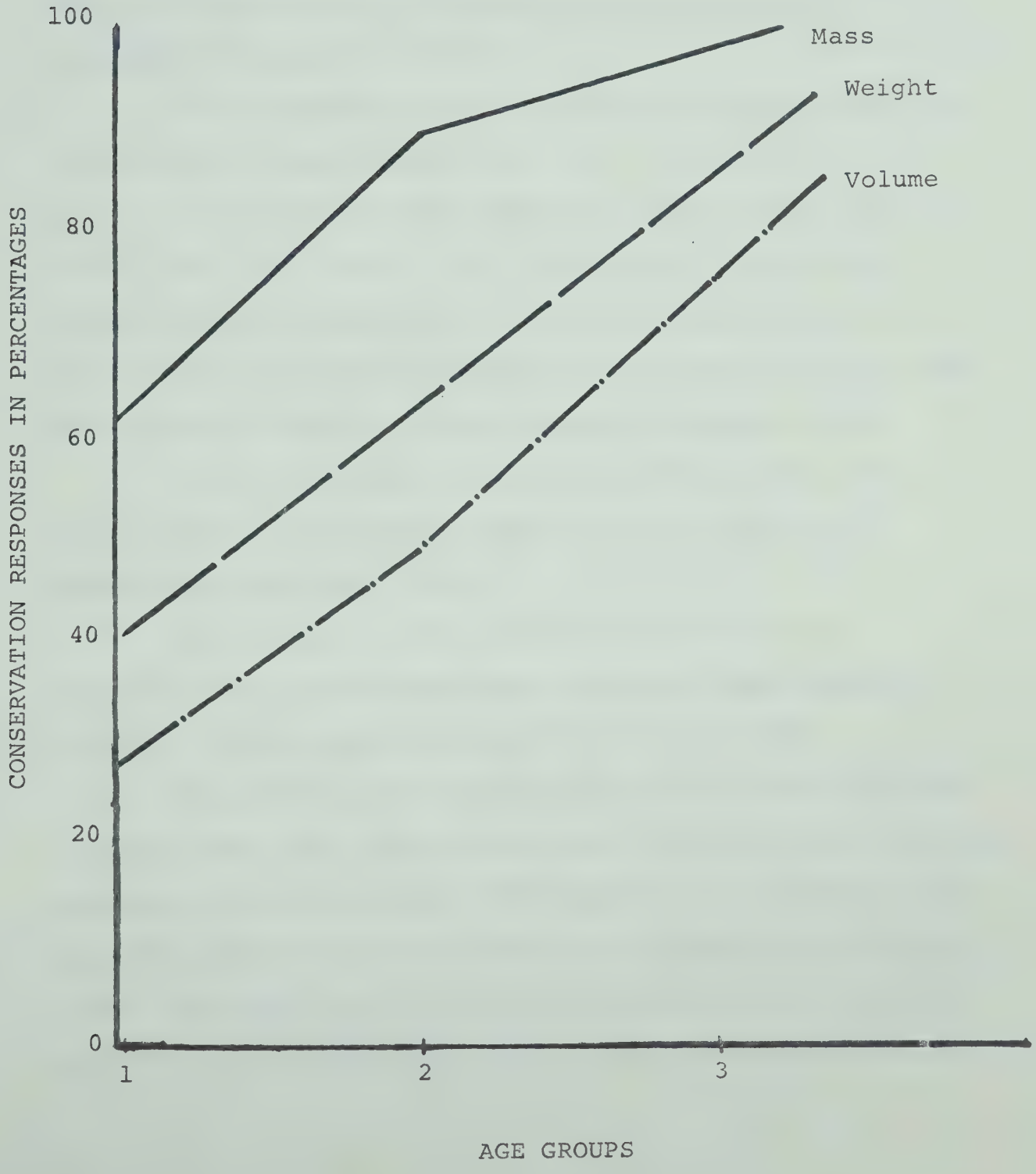
*AI = Age Level 1, AII = Age Level 2, AIII = Age Level 3.

FIGURE 3

Comparisons Between Age Groups, and Between Conservation Tasks (Horizontal Décalage) In Conservation Responses



It was reported that: (a) For mass the 5 - 6 and the 7 - 11 year old groups differed significantly; (b) for Weight the 5 - 8 and 9 - 11 year old groups differed significantly; and (c) for volume the 5 - 10 and the 11 year old groups differed significantly from each other in number of conservation responses given.

In the present study, the use of Scheffe's multiple comparison of means showed that; (a) For mass the 7 - 8 and 9 - 12 year old groups differed significantly; (b) for weight the 7 - 8, the 9 - 10, and the 11 - 12 year old groups differed significantly: and for volume, the 7 - 10 and the 11 - 12 year old groups differed significantly from each other in number of conservations responses given.

Elkind converted the results of his study into percentages for comparison with Piaget's criterion of seventy-five per cent (75%).

The results of the present study were also converted into percentages for comparison with Elkind's results. Percentages are given in Table 11 below.

Observation of Elkind's conservation Table 10 shows that for mass, the seventy-five per cent (75%) criterion was reached at age nine (86%); for weight it was reached at age ten (89%) and for volume it was not achieved at age eleven (25%). Similar results are shown for the present study in Table 11, mass at age nine (85%), weight at age ten (77%),

TABLE 10

Elkind's Study (Sigel et al 1968, p. 16-17)

Percent * of Conservation Responses for Mass, Weight, and Volume of Successive Age Levels. (N = 25 at each Age Level)

Type of Quantity	Age Level 5	6	7	8	9	10	11
MASS	19	51	70	72	86	94	92
WEIGHT	21	52	51	44	73	89	78
VOLUME	0	4	0	4	4	19	25

*of 75 possible responses

TABLE 11

Percent* of Conservation Responses for Mass, Weight, and Volume at Successive Age Levels (N = 20 at each Age Level)

Type of Quantity	Age Level 7	8	9	10	11	12
MASS	47	65	85	90	97	100
WEIGHT	40	35	47	77	82	92
VOLUME	30	22	42	57	67	82

*of 40 possible responses

and for volume, seemingly earlier than Elkind had found, at age twelve (82%).

In conclusion, the present study like Elkind's confirms Piaget's assignment of the conservation of Mass to ages 7 - 8; the conservation of weight to ages 9 - 10; and the conservation of Volume to ages 11 - 12.

The Justification Question

American Children

Children's explanations in Elkind's Study were categorized in the following manner:

(a) Romancing: It's more because "My uncle said so."

(b) Perceptual: It's more because it's longer, thinner, thicker, wider, narrower, etc.

(c) Specific: "You didn't add any or take any away." (Identity)

"You can roll it back into a ball and it will be the same." (Reversibility)

"The hot dog is longer but thinner, so the same." (Compensation)

(d) General: It's the same because, "No matter what shape you make it into it won't change the amount."

Categories (a) and (b) were found to be given by non-conserving children. Table 12 shows percentages for type of explanation at successive age levels.

TABLE 12

Percent for Each of the Four Types of Explanations Given at Successive Age Level

(N = 25 at each age level)

Type of Explanation	Age Level 5	6	7	8	9	10	11
Romancings a *	4	3	7	7	0	1	0
Perceptual a *	85	64	53	57	36	32	33
Specific b *	11	33	40	36	60	51	49
General b *	0	0	0	0	4	16	18

*a = Explanations of non-conservation
b = Explanations of conservation

Elkind reported that Romancing and Perceptual explanations decreased with age while specific and general explanations first increased and then leveled off with age.

Kenyan Children

Explanations given by Kenyan children fitted into three of the four categories given on Table 12. Table 13 shows the percentages for each of the types of explanations given by Kenyan children at successive age levels.

TABLE 13

Percent for Each of the Four Types of Explanations Given at Successive Age Level (N = 20 at each age level)

Type of Explanation	Age Level 7	8	9	10	11	12
Romancing	10	10	4	4	0	0
Perceptual	90	74	61	29	20	12
Specific	0	16	35	68	80	88
General	0	0	0	0	0	0

Kenyan children showed the same patterns as that reported for the American children in their explanations. Perceptual explanations decreased with age while specific explanations increased with age. Not a single Kenyan child gave a general explanation as defined by Elkind and used in the present experiment. Romancing explanations - "It's the same because my uncle said so," and "Magical explanations" (used by Greenfield, 1966, p. 239) - "It's the same because you have poured or deformed it" were not many among Kenyan children. There were only eight magical explanations and no romancing explanations. Table 13 shows the eight magical explanations as romancing since some researchers use the two words interchangeably. The Greenfield study mentioned above

reported that Wolof children achieved conservation through identity rather than reversibility. In the present study only one reversibility explanation was recorded. ("You can roll it back into a ball.") All conserving explanations involved the previous identity or equality of the two balls. ("The two balls were equal before, therefore the pancake is the same as the ball.") This finding was reported among Wolof children too. ("This and that were equal.") Although perceptual explanations can be used to indicate both non-conservation and conservation explanations, all perceptual explanations given by Kenyan children showed non-conservation. Greenfield had also found the same thing among the Wolof children. This phenomenon occurs when children pay attention to one dimension instead of two or three dimensions. ("The pancake is wider" rather than "The pancake is wider but narrower.")

Discussion of Problems Specific to the Present Study

Conservation of Mass

Table 2 shows significant interactions between environment, schooling and age level ($P < .05$). Figures 4, 5 & 6 show these interactions graphically. Figure 4 shows clearly the significant interactions are found only between subjects in the 7 - 8 year old group. Schooling seems to be detrimental to urban children in the first age group (7 - 8

FIGURE 4

4-Way Analysis of Variance Summary
Showing Environment vs Schooling
Interactions on Mass

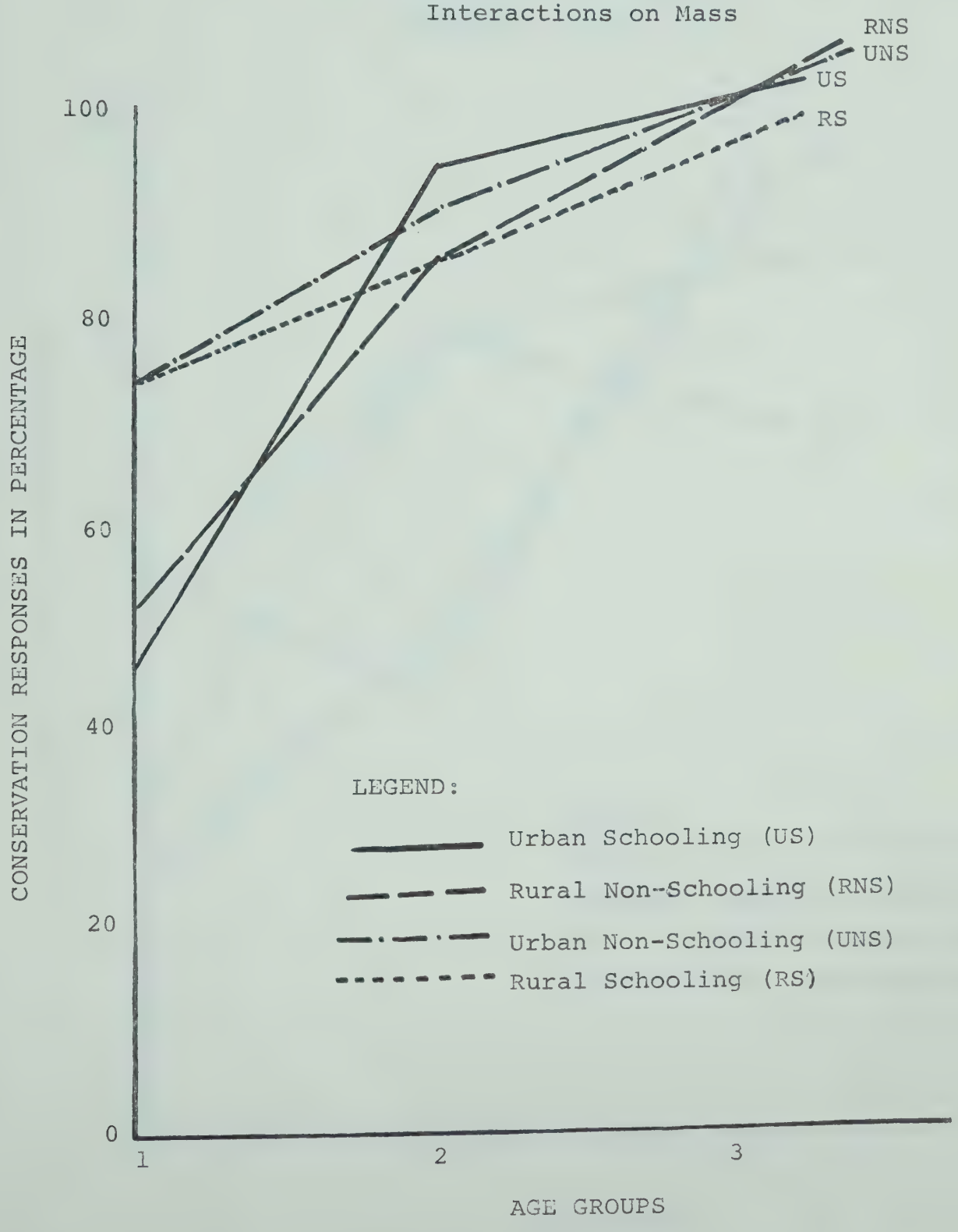


FIGURE 5

4-Way Analysis of Variance, Summary
Showing Sex vs Schooling
Interactions on Weight

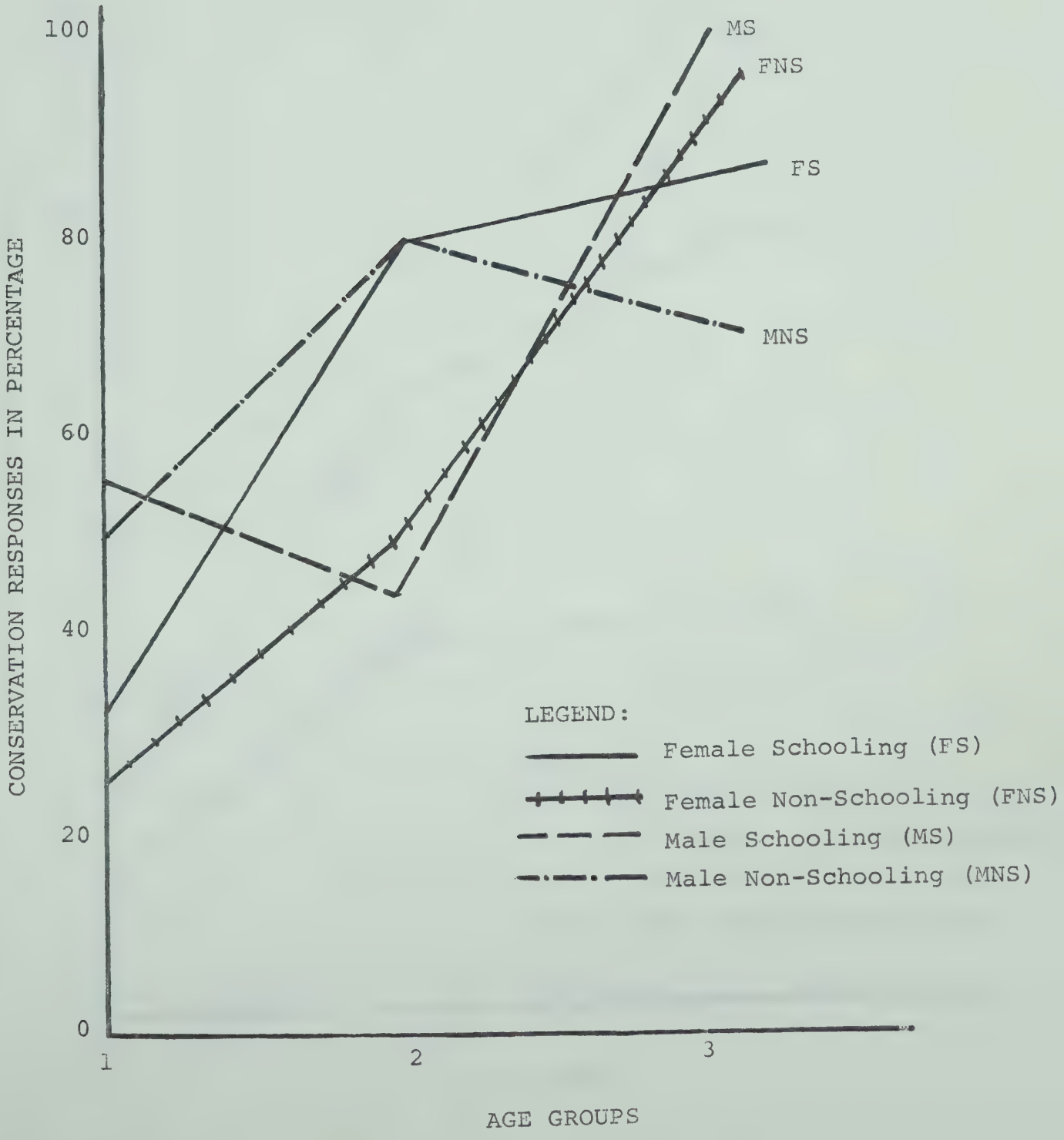
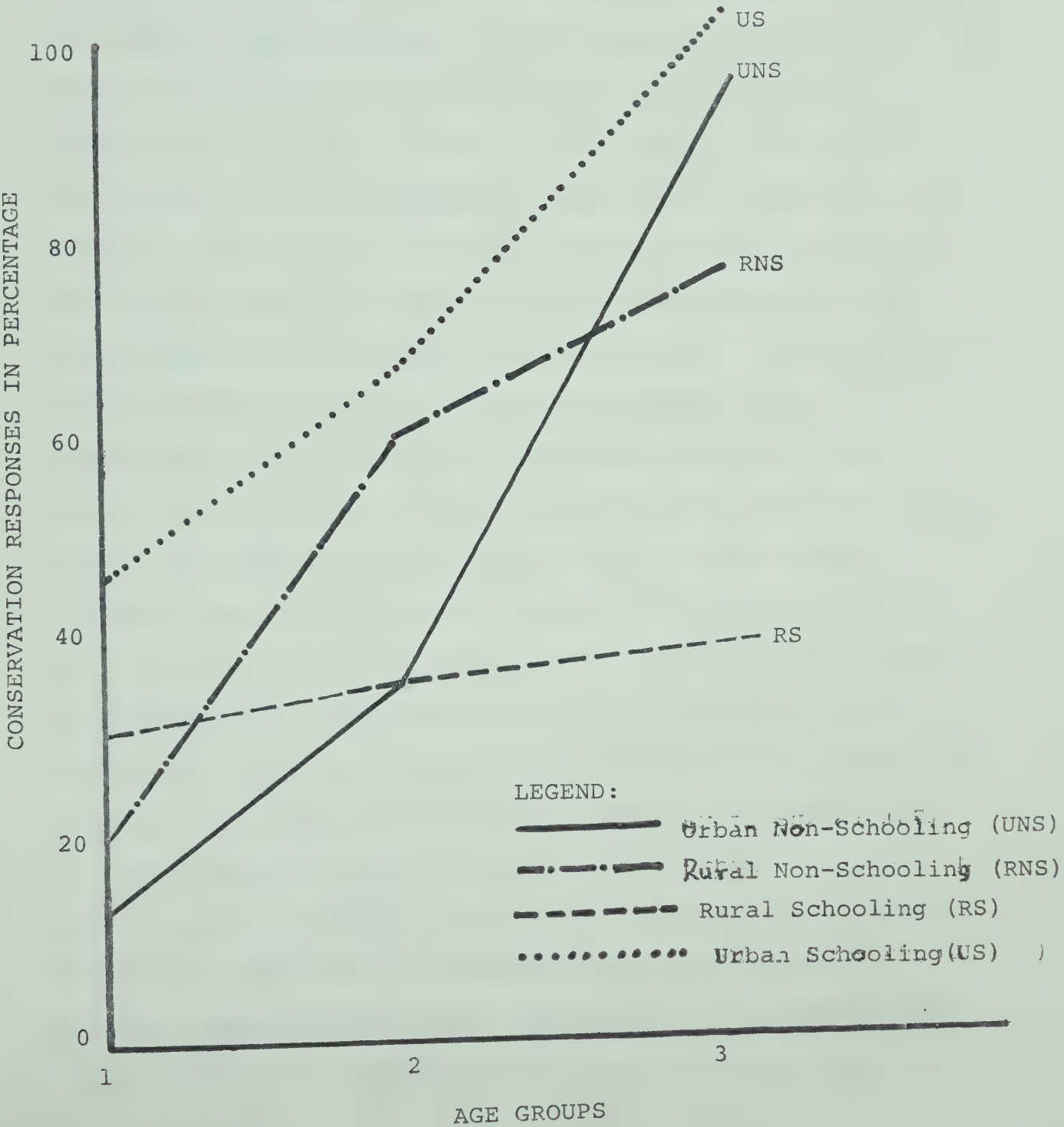


FIGURE 6

4-Way Analysis of Variance Summary
Showing School vs Environment
Interactions on Volume



year olds) and of very little effect on rural children. The point has already been made that Western-type schooling emphasizes analytical perception which may lead school children to give more perceptual responses which are, in most cases, non-conserving. This is more true when the differences between the groups exist only in the non-conserving groups as it does in this study. The writer's explanation for this phenomenon goes back to the first paragraph of the general hypothesis for this study in which it was argued that daily experiences in vital activities are responsible for development of conservation. The unschooled urban children have ample time to go through these experiences while the school children have limited time to do so. Rural school children help with home activities more often than urban children since for some urban school children some activities are done by servants and although they may lack time to do them, (most of their time is given to school work), they may refuse to participate in the activities (such as, sharing food, drawing water, collecting firewood, watching adults playing games). And again some of these activities are no longer necessary in the urban areas, (such as drawing of water and collecting of firewood since most urban homes have water and power supplied). Although schooling may teach them how to think analytically rural children are confronted with more reality as they go

through concrete experience in dissimilar environments during their daily work - and therefore, they are less likely to give perceptual and non-conservation explanations.

Conservation of Weight

Experiences with weight are rare among the Kamba children because they are related to selling and buying which go on at the market places rather than at home. In this study, significant differences occurred between female and male subjects and between school and unschooled children in conservation responses given for weight (see figure 5). These differences are difficult to explain but it is possible that school girls conserve weight earlier than unschooled girls because of the practice they receive in weighing articles in school. At the ages of 9 - 10 years, unschooled girls do not go to the markets alone like boys do and this may be the explanation as to why unschooled boys did better than unschooled girls. On the other hand, school boys are separated from girls during handicraft periods and do outdoor work such as brick work, ropemaking and carpentry while girls spend their periods in doing house work which involves weight practice among other activities. This may explain why school boys scored poorer than school girls.

Conservation of Volume

As for the differences in conservation scores for volume, they are found only between urban and rural school children (figure 6). Since the non-schooling urban and rural children showed non-significant differences, it could be that differences in schooling were responsible for the occurrence of significant differences observed between the two groups.

It was pointed out earlier that children will develop earlier those concepts which are useful and meaningful than those others which are unfamiliar and of no practical use in their life. Accordingly, it seems as if schooling introduces new unfamiliar concepts and formal rules which interfere with rural children and slow their development of conservation. This interference may not be wholly cognitive but it may be concrete in that the rural school children find little time to continue experiencing activities like the unschooled children do. The question then is, What happened to urban school children who did so well in comparison with rural school children? Experiences with water seem to be related to conservation of volume. Both school and unschooled urban children have plenty of water in or outside their houses. They have the same chances of learning the concept of conservation of volume. In this case, school experiences must be responsible for the differences since the syllabus recommends practices in

capacity. This brings the problem of why school experiences should enhance conservation of volume in urban children, and fail to do the same in rural children. The only reason that seems obvious here is differences in teaching and carrying on the recommended exercises in volume and capacity.

Rationale For Leaving out Justification Question

Conservation studies have repeatedly contended that children's explanations for their answers are crucial to their discovery of the concept of conservation. A number of studies (Lloyd 1971; Smedslund 1969, and Dasen 1972 personal communications) have reported some concern about the use of language to determine presence or absence of conservation. If the child can predict the outcome of deformation before it is carried out, and judge the outcome correctly and consistently in presence of perceptual inequality, then this may be sufficient indication for presence of conservation. Conversely, while verbal explanations may be useful in detecting conservation or non-conservation among European children, replication studies in cross-cultural areas have not been successful in using language to assess conservation.

Patterns of responding to the justification question categorize children in the following manner:

(a) Those who give no explanations (NJ)

(b) Those who give inadequate explanations to allow Es to assess conservation

(c) Those who give adequate explanations and are either classified as conservers or non-conservers.

Children in categories (a) and (b) are usually assigned no points. This seems to be an inadequacy in Es rather than in the children because Es have failed to design adequate instrument for measuring children's concrete operations.

The present study (as explained before) used the three criteria to measure conservation. These were:

(a) Prediction Question (P)

(b) Judgement Question (J) and

(c) Justification Question (JF)

All children were classified as follows:

1. Those who explained at least one response (80 children)

2. Those who did not explain any of their responses (40 children).

The question that had to be answered at this point was, "were justifiers better than NJ in their performances for P and J tasks (PJ)?" To answer this question, the following analysis was done. Of the 80 justifiers, 52,42, and 32 children conserved Mass, Weight, and Volume respectively and 34, 18, and 17 of the 40 NJ were conservers in the same

tasks respectively when conservation was measured by PJ criterion (see Table 14).

TABLE 14

Percentage of Conservers Among Justifiers and Non-Justifiers When PJ Criterion Was Used as the Only Measure of Conservation

Quantity	Justifiers N	Justifiers PJ Conservers	Non-Justifiers N	Non-Justifiers PJ Conservers
Mass	80	65	40	85
Weight	80	52	40	45
Volume	80	40	40	42

The mean score for justifiers in PJ was 52 in all three conservation tasks as compared to 57 for NJ. Up to this point justifiers were not significantly different from NJ in their discovery of conservation when PJ criterion was the only measure of conservation. Further analysis showed that, of the 80 justifiers 50, 61, and 74 respectively, justified Mass, Weight, and Volume a process that eliminated 30, 19, and 6 children because they failed to justify their responses for Mass, Weight, and Volume respectively. This analysis can be seen in Table 15. In this table a comparison was made between conservation responses for PJ and PJJ

TABLE 15

Percent of Correct Responses to Prediction and Judgement Questions (PJ) and to Prediction, Judgement, and Justification Questions (PJJ)

Conservation Tasks	Justifiers			Non-Justifiers		
	N	PJ	PJJ	N	N	PJ
Mass	80	65	62	50	40	85
Weight	80	52	54	61	40	45
Volume	80	40	35	74	40	42

(Prediction, Judgement, and Justification tasks) in percentage. It was found that 62% of all justifiers for Mass were conservers when PJJ criterion was used as compared to 65% conservers when PJ criterion was used alone. The percentages of conservers in Weight and Volume were 52 and 54, 40 and 35 for PJ and PJJ respectively. Again the mean score for PJJ was 50 as compared to 52 for PJ.

In conclusion, since the quality of conservation performance for justifiers in PJJ did not differ significantly from their performances in PJ, and since this performance did not differ significantly from the performances of NJ in PJ, and further more, since Es have failed to agree on the use of verbal explanation for discovery of conservation in

cross-cultural studies, it was felt that inclusion of PJJ criterion for conservation had the disadvantage of reducing the total number of subjects by at least one third. Conversely, using the PJ criterion only did not change the quality of conservation but it permitted inclusion of all subjects in the final data analysis. Thus, PJJ criterion was dropped out and PJ was used as sufficient criterion for discovery of conservation.

An important point must be pointed out at this stage about the qualitative aspects of this study. Firstly, for those researchers interested in theory building, these results are in order, but for those whose main interest is individual variations, the results are of little interest until further information is given. The individuals in this study are more real than the abstracted group averages. This statement can hardly be over emphasized in the present study in which twenty-one (21) children out of the total number of one hundred and twenty (120) reversed the order of conservation difficulty. Ten children conserved weight before mass, eleven conserved volume before weight, five conserved volume before mass and two conserved volume before weight and mass; thus, for these children the order of difficulty was like this: volume fourteen (14), weight ten (10) and for mass nine (9). While conservation of mass was reported to be the easiest in this study, for these children

it appears to be the most difficult. These individual variations must be taken into account and kept in mind when abstracted average statements are made especially in conservation tasks. Quantitatively therefore, this study confirmed Piaget's three stages in the development of conservation (a) non-conservation, (b) transitional, and (c) conservation. Similarly, Ogilvie and Lovell's (1960) finding of "no clear cut borders between age stages" was strengthened by the results in this study. While there were differences between age groups it was not possible to predict individual performances according to subjects' ages because in some cases young children who were not expected to conserve some quantities conserved and older ones who were expected to conserve failed to conserve. However, this phenomenon has also been reported in conservation studies in the European culture (Fogelman, 1971; Hallam, 1969). This discussion can be ended with an agreement with Roll's (1970) statement that there are more similarities than differences between Kenyan* and European children performances in conservation tasks.

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*Kenyan inserted by writer.

IMPLICATIONS FOR THIS STUDY

Specific Implications

There has been a tendency for researchers to study one or two of the many tribes in one of the African countries and end up talking about "The African Child" as if the Wolof's thinking structure must be the same as the thinking structure of the Zulu child. The results reported in this study should be generalized to the populations of the two schools (St. Mary's and Kalawa) and to the surrounding areas where the unschooled children were chosen from and to a lesser degree to other subjects whose descriptions are the same as the ones in the present study.

1. The first implication is that schools up to the time of this study had not been beneficial to children's cognitive growth and therefore, some improvement in content or method of teaching should be effected.

2. Children studied here, can benefit from Piagetian diagnostic tests and from Piagetian oriented curricula which have met with success among European children.

3. Individual (or self-regulatory) experiences account for vast variations found between groups, individuals and within subjects, although other factors such as subject's personality, experimenter's bias, and material familiarity cannot be left out. It must be at least one of these factors that accounts for Heron's (1969) conclusion that

"Zambian children reach the 55-60 per cent after eleven years and then level off," which is obviously, contradictory to the findings obtained for conservation of weight in this study.

4. More research is needed which should include a larger number of subjects from the same environments but extended to wider areas before findings of the present study can be taken as factual and real.

IMPLICATIONS FOR EDUCATION

Confirmation of the results of this study, implies changes in curriculum content and teaching methodology because schools have not measured up to their expectation. Lavatelli (1970) has shown that schools can raise the level of equilibration (self-activity) in children by providing free choice of activity. She also feels that since early school curricula include classification, number and space, and seriating activities, all teachers should be made aware of the separate thought processes involved in each area, and the order in which they emerge. She continues:

"Awareness of how structures grow will provide guidelines for the teachers in choosing materials and in knowing what to say to children as they use materials (p. 46)."

And Hooper (1968) has noted that Piagetian oriented curriculum has a general directive - the subordinate role played by logical operations as they subserve all types of directive thought. Accordingly, the results of this study, like others in the European cultures call for a curriculum content that considers the child's developmental status in each area of concentration. In other words, Piagetian tasks should play a large part in schools as diagnostic tests for children's cognitive status to determine grade placement, subject readiness and remedial instructional program. While Piagetian tasks have not correlated significantly with children's performances in school, Carpenter and Lunzer (1955); Feigenbaum (Flavell 1963); and Bozarth (1968) have reported high correlations between I.Q. and conservation tasks. Almy (1966) noted:

"In general, children who are able to conserve at an early age do better in other tests related to mental ability and to beginning reading and arithmetic (p. 84." Further on she reported:

". . . while correlations between progress in conservation and other measures of mental aptitude and school achievement were only moderately high, they were substantial enough and consistent enough to warrant further investigation of conservation (p. 108)."

The point to be emphasized here is that Piagetian tests should not replace but should be used along with other diagnostic traditional tests. The reason for this emphasis stems from the fact that some traditional mental tests such as the Stanford-Binet rely heavily on language skills and as a result Stanford-Binet maximum inter-correlation of one item with all other items has a medium value of .66, with 90 percent between .45 and .85. Piagetian tests have shown very low intercorrelation of one test with all others except tests on clay and water pouring which had a correlation of .66 (Tuddenham 1971). While these low correlations may partly be due to error, they imply specificity of the measured abilities and therefore, these tests may be capable of measuring some cognitive structures that the Stanford-Binet, for instance would not be able to detect.

TEACHING METHODOLOGY

The implication for teachers is exactly what Piaget himself has advised (Ripple 1964).

"The accent must be on auto-regulation, on active assimilation - the accent must be on the activity of the subject. Failing this there is no possible didactic or pedagogy which significantly transforms the subject (p. 1)."

In the present study, school children did not show superior performance although they spend five days a week

"learning." Dienes (in Adler 1963) reporting on the teaching of mathematics noted:

" A variety of action experiences (tactual and kinesthetic) with different materials in different situations is perhaps the best way to lay the foundation for full concrete operational, and ultimately, formal mathematical understanding. (p. 19)." Mathematics is not the only field of study that could benefit from this Piagetian approach to teaching. Hallam (1969) reported that most students up to the age of sixteen years old are still at the concrete operational level of thought and therefore Piagetian techniques may be employed to facilitate learning of history in such students. A summary of some of these techniques appears below.

"1. History in early years of secondary school should not be over-abstract in form nor should it contain too many variables.

2. The materials should match the students' thinking skills.

3. Emphasis should be placed on the concrete aspects of history.

4. Teachers should encourage reversibility in student thinking by presenting contrasting views on particular topics.

5. Careful organized written work dealing with two or more viewpoints should be assigned.

6. Methods by which the past can be made vivid and concrete (visual aids) should be emphasized.

7. Subtlety in moral judgement can be emphasized by considering the motives behind a person's actions. (p. 3)."

RESEARCH IMPLICATIONS

Results from the present study cast doubts on some research procedures in cross-cultural studies. One important implication is that future researchers of cross-cultural studies should, as first requirement, be very familiar with cultural traits and backgrounds of the subjects they test. It is not sufficient to learn a local language. The subjects must feel free to communicate with the experimenter on an equal basis. The use of local assistant researchers while useful is not sufficient. The contradictory results reported in many studies may be actually due to experimenters' disrespect of their subjects' cultural backgrounds if not due to experimental conditions. The use of language to assess cognitive structures in cross-cultural studies is not a sufficient instrument. Verbal explanations may be a sufficient instrument in Geneva, but it should be accompanied by other instruments more equipped to assess cognition in non-Genevan environments. It is suggested that non-verbal instruments that assess cognition through action or through

multiple choice answers may do more justice to cross-cultural studies than the language does.

THEORETICAL IMPLICATIONS

Results have given support to Piaget's general hypothesis that:

1. Cognitive development is greatly due to auto-regulation.
2. Some developmental characteristics of children are universal:
   (a) The first of these factors are patterns of children's responses.
   (b) Another universal factoris the influence of age on discovery of conservation.
   (c) There has been some agreement in the universality of horizontal décalage and
   (d) Sequential development of concrete operations has been relatively universal.

On the whole, Piaget's theory of cognitive development promises a possible breakthrough in its ability to assess some crucial factors in the development of cognition which might have been left out or ignored by maturational theorists who have emphasized hereditary determinants or by environmentalists who have emphasized environmental determinants. Piaget has emphasized both maturational and environmental

factors but these are not sufficient by themselves. The child must be internally and externally involved in his environment.

In addition, the theory is easy to research and creates interest in both children and experimenters. Further studies based on this theory should be able to separate more universal cognitive structures and unique influence of environment from genetic influences.

CONCLUSION

To summarize the implications, the writer feels that Piagetian tasks can be used to provide instruments for assessing readiness of particular children for specific educational experiences which I.Q. tests may not be equipped to detect.

The teacher, furnished with enough information of the children in her class, becomes aware of individual differences that are likely to be found among the children and should feel equipped to decide which concepts she can expect her children to handle comfortably according to age and cognitive functions. This in turn implies that teachers should be reasonably conversant in Piaget's theory of cognitive development and its implications. This writer recommends that:

1. Teachers' Colleges in Kenya provide ample time for student teachers to practice Piagetian tests while they are still in the colleges where they can get guidance.

2. Tests that do not require language be devised and used in cross-cultural setting where language has made it more difficult to interpret children's responses. These tests may take the form suggested and developed by Tuddenham (1971) in which a child's reasoning is inferred from what he does rather than from what he says.

"Lest they learn to say 'the same' merely because it appears to satisfy the examiner, we are now developing items measuring conservation of inequalities where 'the same' is not the correct response . . . . most of our items have several parts, but often . . . . merely replication of each other . . . . included to minimize likelihood of chance success. (p. 67)." If these non-verbal and multiple choice tests prove successful in discovering of concrete operations, researchers will have gone a long way towards solving the problem caused by the use of language in cross-cultural studies.

REFERENCES

REFERENCES

Adler, M., Some Implications of the Theories of Jean Piaget and J. S. Bruner for Education. Toronto: Board of Education Research Department, 1963.

Almy, M. and Chittenden E. and Miller, P. Young Children's Thinking. Studies of Some Aspects of Piaget's Theory. New York: Teachers' College Press, University of Columbia, 1966.

Baker, N. E. and Sullivan E. V. "The Influence of Some Task-Variables and of Socioeconomic Class on the Manifestation of Conservation of Numbers" Journal of Genetic Psychology, 1970, 116(1) pp. 21-30.

Baptiste, H. P. Jr. The Effect of an Equilibrated Methodology on the Acquisition of the Conservation of Quantity. Bloomington: Indiana University, 1969.

Bat-Haee, M. A. Psychological Reports, 1971, V. 28(1) pp. 163-168.

Beilin, H. "Perceptual Cognitive Conflict in the Development of an Invariant Area Concept". Journal of Experimental Child Psychology, Vol. 1, pp. 208-226, 1964.

Blum, A. H. Training for Number Concept. Head Start Evaluation and Research Center. Mass.: University of Boston, Report, D-11, 1967.

Bovet, M. C., Etudes interculturelles du dévelopoppement intellectuel et processus dápprentissage. Revue Suisse de Psychologie pure et Appliquée, 1968, 27, 190-199.

Bozarth, J. O. The Ability to Conserve Quantity of Liquid and It's Relationship to Socioeconomic Background, and Achievement Among Selected Fourth Grade Pupils. Tuscon: University of Arizona, 1968.

Braine, M. D. S. "The Ontogeny of Certain Logical Operations" Psychological Monographs: Vol. 73, No. 5 (Whole No. 475) 1959.

Bruner, J. Contemporary Approaches to Cognition, Cambridge Mass.: Harvard University Press, 1957.

Bruner, J. "The Course of Cognitive Growth". American Psychologist, 1964, 19, pp. 1-5.

Bruner, J. and Associates, Studies in Cognitive Growth, New York: John Wiley and Sons Inc., 1966.

Bruner, J. "The Course of Cognitive Growth", American Psychologist, 1964, 19, pp. 1-5.

Carey, R. and Steffe, L. P. A Study of the Interrelationship of Conservation of Length and its Relations. Athens: University of Georgia, (Paper presented to American Educational Research Association, L.A. Feb. 1969).

Carpenter, T. E. and Lunzer, E. A. "A Pilot Study for Quantitative Investigation of Jean Piaget's Original Work on Concept Formation", Educational Review, 1955, 7, pp. 142-149.

Charlesworth, R. W. "Development and Assessment of Cognitive Structure" in Ripple, E. and Rockcastle, N. V. (editors) Piaget Rediscovered. Ithaca: Random House, 1964.

Ciborowski, T. and Cole, M. "Cultural Differences in Learning Conceptual Rules." In International Journal of Psychology. 1971, Vol. 6, No. 1, pp. 25-37.

Dasen, R. D. "Cross-cultural Piagetian Research: A Summary" in Journal of Cross-Cultural Psychology, 1972, Vol. 3, No. 1. pp. 23-39.

De Lacey, P. R. A Cross-Cultural Study of Classificatory Ability in Australia. Journal of Cross-Cultural Psycholoy. 1970, 1; 293-304(a).

De Lacey, P. R. Verbal Intelligence, Operational Thinking and Environment in Part Aboriginal Children. Australian Journal of Psychology, 1971, 23, 2, 145-149(b).

De Lemos, M. M. The Development of Conservation in Aboriginal Children. International Journal of Psychology, 1969, 4, 255-269(b).

Dempsey, D. A. "Time Conservation Across Cultures", in International Journal of Psychology. 1971, Vol. 6, No. 2, pp. 115-120.

Elkind, D. "The Development of Quantitative Thinking. A Systematic Replication of Piaget's Studies" Journal of Genetic Psychology, 1961, 98, pp. 37-46.

Feigenbaum, K. D. "An Evaluation of Piaget's Study of the Child's Development of the Concepts of Conservation of Discontinuous Quantities," in Flavell, H. J. The Developmental Psychology of Jean Piaget. New York: D. Van Nostrand, 1963.

Flavell, H. J. The Developmental Psychology of Jean Piaget. New York: D. Van Nostrand, 1963.

Fogelman, R. K. Piagetian Tests for the Primary School. London: National Foundation of Educational Research in England and Wales, 1970.

Furby, L. "A Theoretical analysis of cross-cultural research in cognitive development: Piaget's conservation task". Journal of Cross-Cultural Psychology, 1971, 2, pp. 241-255.

Furth, G. H. "Formal Operations and Language: A Comparison of Deaf and Hearing Adolescents," in Internaltional Journal of Psychology, 1971, Vol. 6, No. 1, pp. 49-64.

Furth, G. H. Piaget and Knowledge. New Jersey: Prentice-Hall Inc., 1969.

Galperin, I. P. "Towards Research of The Intellectual Development of the Child". International Journal of Psychology, 1968, Vol. 3, No. 4, pp. 257-271.

Galperin, I. P. "A Method, Facts, and Theories in the Psychology of Mental Action and Concept Formation" in Soviet and East European Papers on Educational Psychology, Presented at the XVII International Congress of Psychology. Moscow, 1966, pp. 45-50.

Goodnow, J. J. and Bethow, G. "Piaget's Tasks: The Effects of Schooling and Intelligence" in Child Development, 1966, Vol. 37, pp. 573-583.

Goonow, J. J. "The Nature of Cross-Cultural Variations in Intelligence Growth".in Hellmuth, J. Cognitive Studies, New York; Bruner/Mazel, 1970.

Green, R. D., et al. Piaget and Measurement. Proceedings of the CTB/McGraw-Hill Conference on Ordinal Scales of Cognitive Development. MOntreal: McGraw-Hill Book Co., 1971.

Greenfield, P. M. "On Culture and Conservation" in Bruner J., Studies of Cognitive Growth. New York: John Wiley and Sons, Inc., 1966.

Hallam, R., "Piaget and the Teaching of History" in Educational Research, 1969, Vol. 12 (1) pp. 3-12.

Helmuth, J. Cognitive Studies. New York: Brunner/Mazel, 1970.

Heron, A. and Simonsson, M. "Weight Conservation in Zambian Children, A Non-Verbal Approach".in International Journal of Psychology, 1969, 4 pp. 281-292.

Hilliard, E. A Comparison Study of the Cognitive Development of Disadvantaged First Grade Pupils (as measured by selected Piagetian Tests) Paper presented to the 49th Annual meeting of the California Educational Research Association, San Diego, April, 1971.

Hooper, H. F. "Piagetian Research and Education" in Siegel, E, I. et al, Logical Thinking in Children, New York: Holt, Rinehart and Winston, Inc., 1968.

Hunt, McV. J. Intelligence and Experiences. New York: Harcourt, Brace Company, 1968.

Hyde, D. M. "An Investigation of Piaget's Thoery of the Development of the Concept of Number" in Flavell, H. J. The Developmental Psychology of Jean Piaget. New York: D. Van Nostrand, 1963.

Hyde, D. M. G. Piaget and Conceptual Development. London: Holt, Rinehart and Winston, 1970.

Jahoda, G. "Assessment of Abstract Behavior in Non-Western Culture" in Journal of Abnormal and Social Psychology. 1956, Vol. 53. pp. 237-243.

Kalmykova, Z. I. "Certain Criteria of Mental Development During the Learning Process" in XVIII International Congress of Psychology, Moscow, 1966, pp. 26-27.

Kaminsky, "A Study of the Status of Conservation Ability in Relationship to Arithmetic Achievement." in Dissertation Abstract International. 1971,Vol. 3(7-A), p. 3341.

Kohnstamm, A. G. Piaget's Analysis of Class Inclusion: Right or Wrong? Paris: Mouton & Co., 1967.

Kincaid, C. and Associates. A Study of Training Nursery Children on Logical Operational Skills. Morgantown: University of Western Virginia, 1971.

Kleinfeld, J. Cognitive Strengths of Eskimos and Implications for Education. Fairbanks: Alaska University, 1970.

Koffka, K. The Growth of Mind. "An Introduction to Child Psychology" London: Ronald Press, 1928.

Kostyuk, G. S. "On Some Aspects of the Problem of Education and Mental Development" in XVIII International Congress of Psychology, Moscow, 1966, pp. 19-22.

Lavatelli, S. C. Piaget's Theory Applied to an Early Childhood Curriculum. Boston: A Center for Media Development Inc., 1970.

Lafrancois, G. "A Treatment Hierarchy for the Acceleration of Conservation of Substance" in Canadian Journal of Psychology, 1968, 22(4), pp. 277-284.

Lloyd, B. B. "Studies of Conservation with Yoruba Children of Differing Ages and Experience," in Child Development. 1971, Vol. 42. pp. 415-428.

Maccoby, M. and Modiano. M. "On Culture and Equivalence I." in Bruner, J. Studies in Cognitive Growth. New York: John Wiley and Sons. Inc., 1966.

Maier, W. H. Three Theories of Child Development. New York: Harper and Row, Publishers, 1965.

McFie, J. "The Effect of Education on African Performance on a Group Intellectual Tests" in British Journal of Educational Psychology, 1961, Vol. 31, pp. 232-240.

McManis, L. D. "Conservation,Seriation, and Transitivity Performance by Retarded and Average Individuals" in American Journal of Mental Difficiency, 1970, Vol. 74 (6).

Mechinskaya, N. A. "Learning and Mental Development" in XVIII International Congress of Psychology, Moscow, 1966, pp. 23-26.

Mehryar, H. Amir. "Father's Education, Family Size and Children's Intelligence and Academic Performance in Iran" in International Journal of Psychology, 1972, Vol. 7, No. 1, pp. 47-51.

Mermelstein, E. et al., The Effect of Various Training Techniques on the Acquisition of the Concept of Conservation of Sbustance. New York: Hofstra University, Hempstead, Feb. 1967; Aug. 1968.

Mink, G. O. "Experience and Cognitive Structure" in Ripple, E. R. and Rockcastle, N. V. (ed.) Piaget Rediscovered. Ithaca: Random House, 1964.

Murray, B. F. "Stimulus Mode and the Conservation of Weight and Number" in Journal of Educational Psychology, 1970, Vol. 61, (4) pp. 287-291.

Murray, N. F. The Acquisition of Conservation Through Social Interaction. Newark: Delaware University, 1971. (Paper presented to American Educational Research Association, N. Y. Feb. 1971).

Nezavadovitz, E. and Pomares, A. "On the Acquisition of Mental Operations by Cuban Children" in Psicologia y Educacion, Jan. 1968, Vol. 5(10).

Oglivie, E. and Lovell, K. "A Study of the Conservation of Substance in the Junior School Children" in British Journal of Educational Psychology, 1960, 30, pp. 109-118.

Overbeck, C. and Schwartz, M., "Training in Conservation of Weight. in Journal of Experimental Child Psychology, 1970, 9(2) pp. 253-264.

Phillips, D. G. An Investigation of Possible Hierarchical Dependency of Four Piaget-type Tasks Under Two Methods of Presentation to 3rd,5th and 7th Grade Children. Florida: Florida State University, Tallahassee, 1967.

Piaget, J. The Language and Thought of the Child. New York: Harcourt, Brace, 1926.

Piaget, J. Judgement and Reasoning in the Child. New York: Harcourt, Brace 1928(b).

Piaget, J. The Child's Conception of Physical Causalty. London: Kegan Paul, 1930(a).

Piaget, J. The Moral Judgement of the Child. London: Kegan Paul, 1932.

Piaget, J. and Inhelder, B.Le Development des quantities chex L'enfant. Neuchatel: Delachauz et Niestle, 1941.

Piaget, J. The Psychology of Intelligence. New York: Harcourt, Brace, 1950(a).

Piaget, J. The Child's Conception of Number. New York: Humanities, 1952(b).

Piaget, J. The Origins of Intelligence in Children. New York: Int. Univer. Press, 1952(c).

Piaget J. The Construction of Reality in the Child. New York: Basic Books, 1954(a).

Piaget, J. "Cognitive Development in Children: The Piaget Papers" in Ripple, R. E. and Rockcastle, V. N. (Eds.) Piaget Rediscovered. "A Report of the Conference on Cognitive Studies and Curriculum Development".Ithaca: Random House, 1964.

Piaget, J. The Early Growth of Logic in the Child. New York: Random House, 1964.

Piaget J., Six Psychological Studies. New York: Vintage Books, 1967.

Rattan, S. M. The Role of Language, Manipulation and Demonstration in Acquisition, Retention, and Transfer of Conservation. Edmonton,Canada: A Ph.D. Thesis, Department of Educational Psychology, University of Alberta, 1970.

Richard, P. G. An Introduction to Piaget. London: Routledge and Kegan Paul, 1970.

Ripple, E. R., "American Cognitive Studies: A Review" in Ripple, E. R. and Rockcastle,N. V. (eds.). Piaget Rediscovered. "A Report of the Conference on Cognitive Studies and Curriculum Development." Ithaca: Random House, 1964.

Ripple, E. R. and Rockcastle, N. V. Piaget Rediscovered: "A Report of the Conference on Cognitive Studies and Curriculum Development." Ithaca: Random House, 1964.

Roll, S. "Conservation of Number. A Comparison between Cultures" in Revista InterAmerican de Psicologia, 1970, Vol. 4(1), pp. 13-18.

Shantz, C. and Sigel, I. E. Logical Operation and Concept of Conservation in Children, A Training Study. Detroit, Michigan: Report No. BR-6-8463. Merrill Palmer Institute, June, 1967.

Sigel, I. E. and Hooper, H.F. Logical Thinking in Children. Research based on Piaget's Theory. New York: Holt, Rinehart and Winston, Inc., 1968.

Smedslund, J. "The Acquisition of Conservation of Substance and Weight in Children: I. Introduction" in Scandinavian Journal of Psychology, 1961, 2 pp. 11-19(a).

Smedslund, J. "The Acquisition of Conservation of Substance and Weight in Children: II.External Reinforcement of Conservation of Weight and of the Operation of Addition and Subtraction." in Scandinavian Journal of Psychology. 1961, 2, pp. 71-84 (b).

Smedslund, J. "The Acquisition of Conservation of Substance and Weight in Children: III. Extinction of Conservation of Weight Acquired "normally" and by Means of Empirical Control on a Balance Scale." in Scandinavian Journal of Psychology, 1961, 2, pp. 85-87 (c).

Smedslund, J. "The Acquisition of Conservation of Substance and Weight in Children: IV. An Attempt at Extinction of the Visual Components of the Weight Concept" in Scandinavian Journal of Psychology, 1961, 2, pp. 153-155(d).

Smedslund, J. "The Acquisition of Conservation of Substance and weight in Children:V. Practice in Conflict Situations Without External Reinforcement." Scandinavian Jouranal of Psychology, 1961, 2, pp. 156-160. (e).

Stafford, G. D. and Renner, W. J. "The Influence of the First Grade Program of the Science Curriculum Improvement Study on the Rate of Attainment of Conservation: in Dissertation Abstracts International, 1970 Vol. 30 (7-A) p. 2862A.

Sonstroem, M. A. "On the Conservation of Solids" in Bruner, J. et al., Studies in Cognitive Growth, New York: John Wiley and Sons. Inc., 1966.

Tuddenham, R. D. "Theoretical Regularities and Individual Idiosyncrasies." in Green, R. D., et al. Piaget and Measurement. Proceedings of the CTB/McGraw-Hill Conference on Ordinal Scales of Cognitive Development. Montreal: McGraw-Hill Book Co.,1971.

Uzgiris, C. L. "Situational Generality of Conservation" in Child Development, 1964, 35, pp. 831-841.

Vernon, E. P. "Environmental Handicaps and Intellectual Development: Part II" in British Journal of Educational Psychology, 1965, Vol. 35, pp. 117-126.

Vygotsky, L. S. Thought and Language. Cambridge Mass: The M.I.T. Press, 1962.

Wallach, L. and Wall, J. A. and Anderson, L. "Number Conservation. The Roles of Reversibility, Addition-Substraction, and Misleading Perceptual Cues" in Sigel, E. I. and Hooper, H. F.Logical Thinking in Children. New York: Holt, Rinehart and Winston, Inc., 1968.

Wei, T. T. D. Piaget's Concept of Classification. A Comparative Study of Socially Disadvantaged and Middle Class Young Children. University of Illinois, 1969. (A Ph.D. thesis).

Winer, J. B. Statistical Principles in Experimental Design New York: McGraw-Hill,1962.

Wohlwill, J. F. et al.,"Experimental Analysis of the Development of the Conservation of Number" in Child Development. 1962, 33, pp. 153-167.

Young, B. S. Inducing Conservation of Number, Weight, Volume, Area and Mass in Pre-School Children. Iowa State University, 1969. (Paper presented to American Educational Association L.A.Feb. 1969).

APPENDICES

APPENDIX A

THE MAJOR RESEARCH DESIGN USED TO DETERMINE EFFECTS OF URBANITATION, SCHOOLING, SEX, AND AGE LEVELS SHOWING CELL MEANS - FOR MASS, WEIGHT, AND VOLUME

Environment	Education	Sex	Age Groups	N	Mass	Weight	Volume
Urban	School	Female	1 2 3	15	3.13	2.93	3.13
		Male	1 2 3	15	3.26	2.40	2.46
	Non-School	Female	1 2 3	15	3.60	2.26	1.60
		Male	1 2 3	15	3.46	2.13	2.13
Rural	School	Female	1 2 3	15	3.46	2.33	1.53
		Male	1 2 3	15	3.33	2.93	1.20
	Non-school	Female	1 2 3	15	3.2	2.06	1.86
		Male	1 2 3	15	3.06	2.60	2.33

APPENDIX B

COMPARISONS OF MEAN SCORES SHOWING THE EFFECTS OF SCHOOLING, URBANIZATION, SEX, AND AGE ON CONSERVATION OF MASS, WEIGHT, AND VOLUME

		Mass	Weight	Volume
Sch.	School	3.30	2.65	2.08
	Non-school	3.33	2.41	1.98
Sex	Females	3.35	2.40	2.03
	Males	3.28	2.66	2.03
Urbani-zation	Urban	3.36	2.58	2.33
	Rural	3.26	2.48	1.73
Age	Age Groups			
	1	2.45	1.60	1.10
	2	3.55	2.52	1.97
	3	3.95	3.47	3.02

APPENDIX C

NUMBER OF SUBJECTS IN EACH OF THE THREE STAGES IN SUCCESSIVE AGE LEVELS AND IN ALL THREE QUANTITIES

Age Group	N	Non-Conservers		Transitional		Conservers	
Mass		n	%	n	%	n	%
7-8(1)	40	9	221/2	14	35	17	421/2
9-10(2)	40	2	5	6	15	32	80
11-12(3)	40	0	0	1	211/2	39	971/2
Weight							
7-9(1)	40	16	40	15	371/2	9	221/2
9-10(2)	40	9	221/2	11	271/2	20	50
11-12(3)	40	2	5	7	171/2	31	771/2
Volume							
7-8(1)	40	24	60	11	271/2	5	121/2
9-10(2)	40	17	421/2	7	171/2	16	40
11-12(3)	40	7	171/2	6	15	15	671/2

APPENDIX D

FAMILY SIZE AND ACHIEVEMENT OF CONSERVATION

Mehryar (1972) reported that intelligence scores of subjects increased with educational level of their fathers and decreased with an increase in the number of siblings. In the present study the fathers of all children were low (less than 4 years of education) to medium (5 - 9 years) and therefore, fathers' education should not have made significant differences in their children's conservation responses. Seventy three (73) children who knew exact number of siblings in their families were chosen and their families categorized following Mehryar (1972). (Small family, 1-3 children; medium family, 4-5 children;and large family, 6 and over). An Age by Family analysis of Variance Test (see Table D1) showed high significant differences between age groups but insignificant differences between family groups.

TABLE D1

AGE (A) BY FAMILY (B) ANALYSIS OF VARIANCE SUMMARY

Source	SS	DF	MS	F	P
SA	56.65	2	28.32	13.22*	.000014
SB	3.50	2	1.75	0.82	.445
SE	145.64	68	2.14		

*Significant P < .01

Further test (Table D2) shows that small, medium and large families did not differ significantly in conservation scores given by their children.

TABLE D2

SCHEFFE'S MULTIPLE COMPARISONS OF MAIN EFFECTS (FAMILY GROUPS)

Row	Column	Contrast	F. Ratio	Probability
1	2	0.475	0.571*	0.567
1	3	0.545	0.719*	0.490
2	3	0.069	0.014*	0.985

*Non-Significant P < .05

The present study finds family size not crucial for achievement of conservation. While studies mentioned by Mehryar (in Mehryar 1972) reported superior performances among children in the small families, the trend in the present study is toward the opposite direction. Medium and large family children's average scores (4.22 and 4.01 respectively) are seemingly larger (not statistically) than the average score (3.7) of children from small families. In conclusion, therefore, for achievement of conservation large families seem to have positive rather than negative effects. (as Piaget would expect to find).